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THE CONDOR

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SLATY SPINETAIL

SYNALLAXIS BRACHYURA

Adult at nest, two-thirds natural size

From a painting by Don R. Eckelberry

THE CONDOR

VOLUME 62 NOVEMBER-DECEMBER, 1960 NUMBER 6

THE SLATY SPINETAIL

By ALDEN H. MILLER

The spinetails of the genus *Synallaxis* and of the family Furnariidae form an important part of the bird life of South America, for there are many species in this group, and usually in any one area some member of the genus is common. I have met five of the twelve species of *Synallaxis* that occur in the Republic of Colombia and have always been impressed with their harsh and oft-repeated notes and their manner of skulking in dense, usually low cover. To a Californian, this habitat preference and the general proportion and posture of the birds suggest Wrentits (*Chamaea fasciata*). Ecologically they are the counterpart of that northern Pacific coastal species, exploiting the dense, low brush growth in a similar way and proceeding chiefly by hopping in the branchwork without use of their wings. They are, however, comparatively sluggish.

In the upper Cauca Valley of western Colombia, there are three species of spinetails which have similar markings. Each has cinnamon patches on the crown and the wing coverts and a partly obscured black region on the lower throat. However, the body color differs in them: the Pale-breasted Spinetail (*Synallaxis albescens*) is the lightest, being almost white below; the Azara Spinetail (*Synallaxis azarae*) is darker, with more brown and olive; and the Slaty Spinetail (*Synallaxis brachyura*) is dark slate with much more contrast of the cinnamon areas (see frontispiece by Don R. Eckelberry).

The Pale-breasted Spinetail is widespread in the tropics, ranging from Costa Rica to Trinidad, Bolivia, and Argentina, and in the Cauca area it occupies the hot valley floor chiefly, extending upward locally to the lower Subtropical Zone. The Azara Spinetail is a bird of the Subtropical and Temperate zones and ranges from Colombia and western Venezuela to Bolivia. We found it replacing *albescens* at 6000 feet on the western Andes. The Slaty Spinetail is again a bird of the Tropical Zone, sympatric with *albescens* and ranging from Honduras to western Ecuador.

In the floor of the Cauca Valley, 12 kilometers north of Yumbo, 3800 feet, on December 30, 1958, Mrs. Miller and I found Slaty Spinetails common in the thorn scrub at the edge of the arid western foothills. Here there were organ pipe and opuntia cactuses intermingled with mimosa and catclaw tangles. We estimated that there were at least six of these birds in an area of four acres interspersed with the species *albescens*. *Brachyura* had a deep, heavy chatter that suggested the scolding notes of wrens of the *Thryothorus* group and it seemed to move greater distances through the scrub than did the smaller (20 per cent), weaker-voiced *albescens*. We noted some nests constructed like the one drawn by Eckelberry from his acquaintance with *brachyura* in Costa Rica.

The nest of the Azara Spinetail is a covered mass of sticks, which are not thorny. Unlike that of the Slaty Spinetail it has a horizontal entry tube a foot long, the walls of which are thin and can be seen through. Two such nests of *azarae* at 6500 feet, 4 kilometers north of San Antonio, held two, unmarked white eggs each on March 27 and April 28. Both sets were fresh but complete. The main part of the nest, which is about two feet across, has a roof thatch some six inches thick which protects the softly lined inner nest cup from rain.

Museum of Vertebrate Zoology, Berkeley, California, October 24, 1960.

THE ANNUAL CYCLE OF THYROID ACTIVITY IN WHITE-CROWNED SPARROWS OF EASTERN WASHINGTON

By A. C. WILSON and DONALD S. FARNER

It is now evident that many species of plants and animals have long period physiologic cycles. In birds, the most striking of these cycles have a period of one year. Familiar examples are the annual cycles in organs associated with reproduction and migration (Farner, 1955, 1958, 1959). Less familiar are the annual cycles in such organs as the liver (Oakeson, 1953) and the thyroid gland (Höhn, 1950) whose relation with reproduction or migration is not clear.

Some annual physiological cycles are caused by cyclic factors in the environment. For instance, day length has been demonstrated to be the main cause of the annual occurrence of testicular development in certain passerine birds (Farner, 1959). On the other hand, internal mechanisms have been suggested to be the sole cause of some physiological cycles including annual cycles (Webb and Brown, 1959).

The present paper is concerned with the annual cycle of thyroid activity in a passerine species. Despite the many investigations of annual cycles of thyroid activity in passerine birds, there is still no agreement concerning the form of a typical thyroid cycle. Our first objective, necessarily, has been a quantitative description of the principal features of the thyroid cycle in the bird selected for investigation, *Zonotrichia leucophrys gambelii,* a race of the White-crowned Sparrow. This race and other representatives of the genus *Zonotrichia* have already been used for many studies of annual physiological cycles. A good opportunity was thereby provided to examine the relation of the thyroid cycle not only to cyclic environmental factors but also to other physiological cycles. Evidence has been obtained which suggests that the thyroid cycle in *Z. l. gambelii* is caused mainly by a cyclic environmental factor, very probably temperature.

While our investigations were in progress in Washington, somewhat similar studies were carried out independently on the same race in California and Alaska by Oakeson and Lilley (1957, 1960). This now permits an important series of comparisons.

ACKNOWLEDGMENTS

This paper is based extensively on a thesis submitted by the senior author in partial fulfilment of the requirements for the degree of Master of Science at Washington State University. The research was supported by funds made available by the State of Washington Initiative No. 171. Some of the investigations were performed at the University of California with facilities generously provided by Dr. W. B. Quay. We are indebted also to Dr. B. B. Oakeson of the University of California at Santa Barbara for helpful discussions and for kindly permitting us to read her paper before publication.

MATERIALS AND METHODS

Birds used.—The birds involved in this investigation, except two mentioned later, were obtained in the southeastern part of Whitman County, Washington (latitude 46°N). They were taken either from a wintering population near Wawawai in the Snake River Canyon or from migrating flocks near Kamiak Butte. Eighteen samples, a total of 100 birds, were used to determine the course of thyroid activity through the year. Of these, 75 birds were caught with mist nets from September 29, 1955, to May 5, 1956. They were weighed in the field and brought alive to the laboratory where they were killed. Both thyroid glands were removed and preserved. Observations at the time of death were made also on body weight and molt. The gonads were preserved for weighing as described by Farner and Wilson (1957).

The interval between capture and death was usually from 3 to 10 hours, but in certain instances, noted later, the birds were kept for a few days in outdoor aviaries (4×2.7×2 meters) where they were exposed to conditions of lighting and temperature natural for the locality. To test whether the 3-to 10-hour period between capture and death affected thyroid activity, an additional group of 10 birds was captured on January 2, 1957. The thyroids were removed from four of these birds at the time of capture for comparison with the thyroids of the remaining six birds which were killed six hours later at the laboratory.

Information about the state of the thyroid gland in summer was obtained from two sources: (1) Two breeding birds which were shot on July 15, 1956, near Hart's Pass, Okanogan County, Washington (elevation about 7000 ft., latitude 49°N). (2) Thirteen birds which were caught during the winter of 1954–1955 and kept in the outdoor aviaries until the summer of 1955.

During maintenance of birds in the outdoor aviaries, under the same conditions observed by Farner and Wilson (1957), a nutritionally adequate, chick-starter mash and water were always available. The body weight and testicular development of birds under these conditions does not differ essentially from those of birds in the wild population. Also, prenuptial molt, fat deposition and migratory unrest or *Zugunruhe* occur in spring at exactly the same time as in the wild population, even if the birds are confined to small outdoor cages (King and Farner, 1956, 1959). Likewise, it has been observed by several investigators in this laboratory (unpublished) that loss of spring fat, testicular regression, postnuptial molt, autumnal fat deposition and *Zugunruhe* proceed in the same sequence as these events in the natural populations of this race studied elsewhere by Blanchard and Erickson (1949) and Oakeson (1954). It is reasonable, then, to assume that thyroid activity of such aviary birds should also reflect closely the thyroid activity of natural populations.

In addition to the description of the natural annual cycle of thyroid activity, experiments were conducted indoors under controlled conditions of lighting, temperature and nutrition in the manner described previously (Farner and Wilson, *op. cit.*; King and Farner, 1956, 1959).

Preparation of thyroids for measurement.—Both thyroid glands were removed within a few minutes after death and fixed in Bouin's mixture. They were embedded in paraffin by the conventional, alcohol-paraffin technique. Sections, 6μ thick, prepared from one or both thyroids, were mounted on slides and stained with Harris' haematoxylin and eosin. Care was taken to use exactly the same technique of preparation for all thyroid sections.

Measurement of thyroid activity.—Thyroid activity was measured by the method developed by Uotila and Kannas (1952), Tala (1952), Lever and Vlijm (1955), and Wahlberg (1955). In this method, the percentage of secretory epithelium (E%) in the gland, an experimentally tested index of thyroid activity, is measured on sections of the gland. Preliminary tests on the thyroids of White-crowned Sparrows showed that a value of E% not farther away from the true value than about 5 units could be obtained from a single section through the middle of either of the two glands. The central part of the image of such a section was projected on a piece of paper with two straight lines, each 20.0 cm. long, intersecting at right angles. The magnification of the image was 520 and the total length of tissue measured 40.0/520 cm., that is 770μ—a distance that traverses between 20 and 30 thyroid follicles in these birds.

Environmental temperature.—Semi-monthly means of the daily maximum and of the daily minimum air temperatures at the weather stations nearest the collecting areas were computed from the records for 1955–56 in the "Climatological Data" of the United

States Weather Bureau. The mean temperature for each half-month was then obtained by averaging the average daily maximum and the average daily minimum. Monthly averages, computed in an analogous way, were taken directly from these climatological data.

RESULTS

Description of the thyroid cycle.—Table 1 gives the dates for the 17 samples of birds taken for this study through the year 1955–56. The table also contains data from

Table 1

Annual Cycles of Molt, Body Weight, Migration and Testicular Weight

Date caught	Date killed	Number of birds	Number in molt	Mean body weight in grams	Number of males	Mean weight of testes in milligrams
Winter	July 30	6	6	26.6	4	2
of 1955	Aug. 27	7	0	27.1	5	2
Sept. 29	Oct. 1	6[1]	0	26.1	4	1
Oct. 6	Oct. 6	6[1]	0	28.2	2	1
Nov. 10	Nov. 10	3	0	26.4	2	1
Nov. 19	Nov. 19	6	0	26.9	4	1
Dec. 8	Dec. 8	6	0	27.3	5	1
Dec. 23	Dec. 23	3	0	29.2	3	1
Jan. 13	Jan. 13	6	0	27.6	6	1
Jan. 26	Jan. 26	3	0	27.4	3	1
Feb. 10	Feb. 10	9	0	26.1	4	1
Mar. 10	Mar. 10	6	0	26.0	6	1
Apr. 4	Apr. 4	3	3	26.2	2	5
Mar. 10	Apr. 6	3	3	29.2	3	5
Apr. 21	Apr. 21	5	1	28.3	4	13
May 5	May 5	10[1]	0	26.8	4	50
.....	July 15	2	1	.....	1	....

[1] Migrating.

these samples concerning several annual physiological cycles other than the thyroid cycle. The data show the cyclic nature of molt, body weight, migration and testicular weight and are in general agreement with previous data concerning these cycles in natural populations of *Z. l. gambelii* (for example, Blanchard and Erickson, 1949; Oakeson, 1954). There is reason, then, to expect that this set of samples should also provide a picture of the annual course of thyroid activity that is typical of the populations studied.

Table 2

Effect of Experience between Capture in the Field and Death in the Laboratory on Thyroid Activity (E%)

	At time of capture	Six hours later in the laboratory
Mean E%	73	75
Number of birds	4	6

Further evidence that these samples should reflect the natural state of thyroid activity is given by the results (table 2) of an experiment on an eighteenth sample of birds collected in the following winter (1956–57). The results show that the experience between capture in the field and death hours later in the laboratory does not affect thyroid activity appreciably.

The results of the thyroid measurements made on the 17 samples of birds taken in 1955–56 are presented in figure 1 (solid circles). Statistical analysis confirms what is

immediately apparent by inspection, namely, that there is a marked cycle of thyroid activity through the year. According to Student's t-test, the mean value of E% for any sample of birds taken on a particular day from October through March is significantly higher than that of samples taken from May through August. When plotted against time, the sample means form a smooth curve that passes within the standard deviation of each sample mean. As the standard deviation is never very large (average coefficient of variation equals 12 per cent), it is suggested, on the grounds of simplicity, that the smooth curve is a better representation of the thyroid cycle than the irregular line that could be obtained by going through each of the sample means.

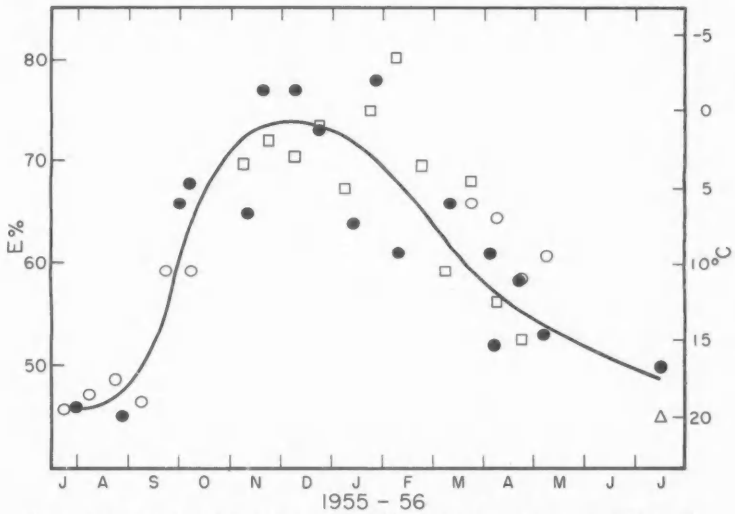

Fig. 1. Annual cycles of thyroid activity (E%) and air temperature for *Zonotrichia leucophrys gambelii* in eastern Washington. Each solid circle represents the mean thyroid activity for a sample of birds taken on a particular date. The curve has been fitted to the solid circles by eye. Half-monthly means (1st to 15th, and 16th to the end of each month) of temperature at the nearest weather station are represented by empty circles (Pullman, Whitman County), squares (Wawawai, Whitman County), and triangles (Winthrop, Okanogan County).

Although it was not verified that such an annual cycle occurs every year, one piece of evidence favoring this interpretation can be offered. As will be recalled, an eighteenth sample of birds was collected in the winter of the following year. The results from these have been presented in table 2 where it is seen that the mean value of E% for these 10 birds is 74, which is in good agreement with the winter values of the previous year.

It can be mentioned at this point that no significant differences in E% were demonstrable between males and females or between first-year and adult birds. Hence, in the results just mentioned, as well as in the experimental results presented beyond, all four of these categories are included.

Correlation of thyroid activity with air temperature.—The shape of the curve of thyroid activity is remarkably similar to the general form of the annual cycle of air temperatures to which the birds were subject. This is readily apparent in figure 1 and has been confirmed by the following statistical test. For this test, E% values were

read from the curve in figure 1 at the end of each half-month period and plotted against the mean temperature for that half-month, T (°C.). Half-month periods preceding the day to which E% values correspond were chosen because it is known that, under laboratory conditions, small birds take roughly half a month to adapt their metabolic rate fully to a new temperature (Gelineo, 1955). Evidence was also obtained in our own investigations that complete adaptation of thyroid activity of *Z. l. gambelii* to a new temperature could take place within less than half a month.

Upon plotting the data relating E% and T it appeared that the relation was linear. The straight line of best fit, calculated by the method of least squares is

$$E\% = 71.3 - 1.22\,T$$

The coefficient of correlation (r) between E% and T is relatively high; $r = -0.84$, after correction for the small number of points involved. The range of r encompassed by three standard errors, computed by means of the z-transformation (Waugh, 1943), is −0.51 to −0.96, which shows that the value of r is very significantly different from zero. The correlation between E% and the average temperature during the preceding half-month is, therefore, surprisingly close, in view of the large random errors to which the individual values of E% and T must each be subject. This suggests that the annual cycle of air temperatures may be the cause of the annual cycle of thyroid activity in these birds.

Experiments with temperature and day length.—If the annual cycle of thyroid activity in White-crowned Sparrows is due to air temperature, thyroid activity would be expected to change in response to artificial changes in air temperature. To test this, six birds that had been living in the outdoor aviaries in winter (average temperature 0°C., day length 8 hr.) were brought indoors (temperature 26°C., day length 8 hr.). The thyroid activity of these birds decreased from the prevailing winter level (mean E% >70) to a value typical of summer thyroids (mean E% = 47) in less than 7–11 days. Although it is possible that some overlooked indoor factor was responsible for this striking change in thyroid activity, it appears likely that the factor responsible was the temperature.

It was also thought in view of the foregoing that thyroid activity of this species should not change when other factors that are cyclic in the natural environment are

Table 3

Effect on Thyroid Activity (E%) of Treating Birds with Daily Photoperiods of Different Length

Experiment	Air temperature in degrees centigrade	Duration of experiment in days	Short photoperiods[1]		Long photoperiods[1]	
			Number of birds	Mean E%	Number of birds	Mean E%
1	26	0	....	....	6	47
		6	....	....	6	46
		12	....	....	6	51
		18	....	....	6	50
		24	....	....	6	55
		30	....	....	6	36
2	12	23–26[2]	4	42	4	42
3[3]	26	0	4	50	....	....
		10	5	53	5	49
		22	4	48	4	52

[1] Short photoperiods were 8 hours in experiments 1 and 3, and 9 hours in experiment 2. Long photoperiods were 18 hours in experiment 3 and 20 hours in experiments 1 and 2.
[2] In experiment 2 there was also an initial period of 6 days during which the photoperiod was progressively lengthened from 9 hours to 20 hours. This experiment was performed by Dr. J. R. King, who kindly allowed us to examine the thyroids of the birds (King and Farner, 1956).
[3] All birds used in this experiment were castrates.

artifically changed. The following experiments show that changes in day length have no effect on thyroid activity under the conditions employed. Birds that had been adapted in winter to room temperature (12°C. or 26°C.) and winter day lengths (8 hr.) were exposed to long day lengths (18 or 20 hr.). Table 3 summarizes several experiments of this sort. It shows that these birds did not change their thyroid activity appreciably in response to the long day lengths. Furthermore, because long day lengths induce many physiological changes in these birds, such as gonadal development, a light molt, and fat deposition, it can be concluded that none of these internal changes affect thyroid activity.

Included in table 3 are the results of an experiment performed with castrated birds. The birds were castrated at least a month before the beginning of the experiment to allow complete healing. After the experiment it was verified, by examination of serial sections of the areas normally occupied by the gonads, that castration had been complete. Castrated birds were used because of the possibility that sex hormones depress thyroid activity in birds (Benoit, 1950; Maqsood, 1952). It was possible, therefore, that any increase in thyroid activity that might tend to occur in response to long photoperiods would be checked in normal birds by sex hormones produced by the rapidly developing gonads. Nevertheless, as can be seen in table 3, E% was not affected by the photoperiodic treatment whether or not the birds were castrated.

DISCUSSION

The thyroid cycle of the race Z. l. gambelii.—The results of our investigation show that there is a striking annual cycle of thyroid activity in *Z. l. gambelii* of eastern Washington. In addition, two lines of evidence have been obtained which are consistent with the view that the cycle found is caused by the annual cycle of air temperature. The first line of evidence shows that thyroid activity in wild populations is closely correlated with the mean air temperature during the preceding half-month. Indeed the correlation may possibly be closer than the statistical test indicated because of errors not only in the values of E% but also in the values of temperature used. So it is perhaps worth pointing out some major errors to which the values of temperature used are subject. First, the actual average temperature for a half-month period is only approximately indicated by averaging the daily maxima and minima. Second, the average air temperature that the birds experienced was probably never quite the same as that at the weather station a few miles away. Third, it is unlikely that thyroid activity could be expected to reflect even the actual average temperature experienced during the preceding half-month. Rather, one would expect some average temperature weighted in favor of the preceding few days to be reflected.

The experimental results provide the second line of evidence consistent with the view that the thyroid cycle found is due to the annual cycle of temperature. In these experiments temperature appeared to affect thyroid activity strongly enough to account for the amplitude of the thyroid cycle in wild birds. But neither day length nor any of the physiological changes induced by long photoperiods affected thyroid activity detectably.

A further line of evidence in favor of this temperature hypothesis comes from comparing the results of our investigation with those of the recent extensive investigations of Oakeson and Lilley (1960) on the same race. These authors have studied thyroids from birds on wintering grounds in California (lat. 34°N) and on breeding grounds in Alaska (lat. 62–65°N). Their birds, in distinct contrast to ours, were found to show no great change in the monthly mean of thyroid activity, as measured through the course of the year by another histological index. The absence of a pronounced cycle of thyroid activity appears to be connected with the fact that the amplitude of the cycle of temperature their birds experienced was small, probably 5°C. Thus the monthly mean tem-

Table 4

Annual Cycles of Thyroid Activity of Passerine Species in Regions Where There Is a Pronounced Annual Cycle of Air Temperature[1]

Species	Period of the Year[2]				Reference
	Winter	Molt	Migration	Reproductive activity	
Passer domesticus	X	O	....	O	Watzka, 1934
	O	X	....	X	Küchler, 1935
	X	X	....	O	Woitkewitsch and Nowikow, 1936
	X	O	....	O	Miller, 1939
	X	X	....	X	Gál, 1940
	O	X	....	....	Bigalke, 1956
Passer montanus	O	X	(X)	O	Küchler, 1935
	X	X	....	O	Woitkewitsch and Nowikow, 1936
	O	....	....	....	Gál, 1940
	(X)	O	....	X	Nakamura, 1958
Emberiza citrinella	O	X	(X)	O	Küchler, 1935
Zonotrichia leucophrys	X	O	O	O	present authors
Serinus serinus	X	X	....	O	Takewaki and Mori, 1944
Chloris chloris	O	X	(X)	X	Schildmacher, 1956
Fringilla coelebs	O	X	....	X	Bigalke, 1956
	....	....	X	X	Gál, 1940
	....	X	....	O	Vaugien, 1948
Pyrrhula pyrrhula	X	....	....	....	Gál, 1940
	O	....	....	....	Putzig, 1937
Loxia pytyopsittacus	O	....	....	....	Putzig, 1937
Loxia curvirostra	X	....	....	....	Putzig, 1937
Bombycilla garrulus	O	....	....	....	Putzig, 1937
Oriolus oriolus	....	....	X	....	Gál, 1940
Parus major	O	X	....	X	Bigalke, 1956
	O	X	....	O	Vaugien, 1948
Sylvia communis	O	....	....	....	Merkel, 1938
Muscicapa striata	....	....	....	X	Gál, 1940
Erithacus rubecula	O	X	X	O	Küchler, 1935
	O	....	....	....	Merkel, 1938
Turdus merula	O	X	....	X	Bigalke, 1956
Turdus viscivorus	X	....	....	....	Gál, 1940
Turdus pilaris	O	....	....	....	Gál, 1940
Turdus philomelos	....	....	X	....	Gál, 1940
Hirundo rustica	....	X	....	....	Gál, 1940
Sturnus vulgaris	O	....	....	X	Burger, 1938
	O	X	....	X	Bigalke, 1956
Garrulus glandarius	....	....	....	X	Gál, 1940
	O	....	....	....	Putzig, 1937
Pica pica	X	....	....	X	Gál, 1940
Corvus frugilegus	O	....	....	....	Gál, 1940
Corvus corone	O	....	....	X	Haecker, 1926
Instances of X	11	17	4	14	
Instances of O	22	4	1	11	

[1] A pronounced annual cycle of air temperature is defined, for present purposes, as one in which the mean temperature of the coldest winter month is at least 20°C. lower than the mean temperature of the hottest month of the year.

[2] Thyroid activity in each period is symbolized as follows: X or (X), high or intermediate at some time; O, low throughout; ...., no observation reported. Sometimes the reason no observations are reported for migration is that the species is not migratory, as in *Passer domesticus*.

peratures from October to April, on the wintering grounds, ranged between 12°C. and 17°C. From late May to August, on the breeding grounds, the mean temperatures also appear to have fallen within this same range. By contrast, in eastern Washington where our investigations were carried out, the amplitude of the annual cycle of monthly mean temperatures is much greater, namely 20°C. (0°C. to 20°C.). This, therefore, constitutes a third line of evidence that the pronounced cycle of thyroid activity encountered in our investigations is due to the pronounced cycle of temperature involved. Conversely, therefore, the lack of a pronounced cycle of thyroid activity encountered in the investigation of Oakeson and Lilley may be due to the lack of a pronounced cycle of temperature.

It should be noted that a second inference can tentatively be drawn from comparison of the results of the present investigation with those of Oakeson and Lilley (1960) on the same race of birds. Since the two groups of birds studied belong to the same race, they must be genetically similar. Yet one group exhibits a pronounced thyroid cycle whereas the other does not. As only the environments of the two groups are very different it seems that the thyroid cycle is more likely to have an environmental cause than an innate cause. This inference appears to stand regardless of whether we have been correct in suggesting that the external cause is temperature.

The thyroid cycles of other passerine birds.—Although our three lines of evidence give strong support to the hypothesis that air temperature is responsible for the main features of the annual cycle of thyroid activity in *Z. l. gambelii*, the majority of passerine species investigated do not appear to exhibit high thyroid activity in cold winters. In order to support this assertion, an attempt has been made to present (table 4), for the first time, a summary of observations made on thyroid activity of passerine species in regions where there are pronounced annual cycles in air temperature. A pronounced annual cycle of temperature is defined, for present purposes, as one in which the mean temperature of the coldest month is at least 20°C. colder than that of the hottest month of the year. The criteria for thyroid activity in the table are histological except in the case of Vaugien (1948) who used thyroid weights. In 12 of the 34 cases in which winter thyroids were examined, no observations were reported for other times of the year; in these cases the authors simply report that thyroids were active or inactive relative, presumably, to the thyroid activity of some other species in winter. In the remaining 22 cases, winter activity is relative to activity at some other time of the year. Even if consideration is restricted to these 22 cases, it is apparent that in the majority (13) of them thyroid activity is reported not to be high in winters that are 20°C., or more, colder than summers in the same region.

It might have been expected that thyroid activity of all birds should be higher in cold winters than in summer. For it is well known that warm adapted laboratory homeotherms raise their thyroid activity after a week or two in a cold environment (Hensel, 1955; Hart, 1958). Because of this the basal rate of energy metabolism rises thereby helping the animals to maintain their normal body temperature in the cold environment. Hence the many instances of birds that do not show histological signs of high thyroid activity in cold winters requires explanation.

One possible explanation is that the role of the thyroid in mediating the rise in basal metabolic rate in response to cold is not important in these cases. Experimental evidence obtained with rodents suggests that the thyroid need not have an essential role in this response (Hart, 1958). This opens the possibility that the relative role of the thyroid in adjusting the basal metabolic rate to cold may differ in different species.

Another possible explanation, as Dr. Oakeson reminded us, is that other mechanisms of adapting to cold may be used by some species to the virtual exclusion of the

mechanism involving basal metabolic rate. Insulative mechanisms, increased muscular activity (Scholander *et al.*, 1950; Hart, 1958) and, in extremes of cold, lowered body temperature (Steen, 1958) are all instances of such mechanisms found to operate in small birds.

A third possible explanation of the failure of many birds to exhibit elevated thyroid activity in cold winters might be that in these birds thyroid activity is not reflected histologically. Until recently a close correlation between the results of radioactive and histological methods of measuring thyroid activity had been observed in laboratory homeotherms. Recently it was suggested that hamsters may be an exception to this rule (Knigge, 1957). However, it appears that Knigge's interpretation may not preclude the possibility that his results were due to an influence of light. Light has been shown to affect thyroid activity of other rodents (Puntriano and Meites, 1951; Soliman, Badawi, and Ghanem, 1958). Nevertheless, even if hamsters are not a real exception, the possibility remains that some of the passerine species evincing no histological signs of high thyroid activity in cold winters are exceptions. That is to say, these species might be found by radioactive methods to have high thyroid activity in cold winters.

As is apparent also in table 4, many investigators have reported that thyroid activity is relatively high at periods of the year other than winter. Commonest are the periods of molt, reproductive activity (that is, gonadal development or breeding), and migration. However, careful examination of our data gives no evidence that thyroid activity is elevated in any of these periods in *Z. l. gambelii*. Comparable results were obtained by Watzka (1934) and Miller (1939) with *Passer domesticus*. Miller's results were obtained by measurements of metabolic rate as well as by histological methods.

Again, it is difficult to reconcile the differences in the results of different investigators. If the results are accepted as providing valid pictures of the annual cycles of thyroid activity in passerine birds, then it follows that different species in similar climates must differ enormously in the form of these cycles. Indeed, if this explanation is accepted, populations of *Passer domesticus*, in different geographic areas of the northern part of the north temperate zone, must also differ enormously in their annual cycles of thyroid activity (table 4). However, it should be recalled that the experimental evidence that molt (Höhn, 1950), reproductive activity (Benoit, 1950; Maqsood, 1952), or migration (Farner, 1955) are naturally dependent on especially enhanced thyroid activity has never been more than suggestive. Even the best supported case, that of molt, has now been questioned because of recent experiments on the domestic fowl (Shaffner, 1954; Tanabe, Himeno, and Nozaki, 1957; Juhn and Harris, 1958).

It is evident that much remains to be done before a satisfactory understanding of the forms and causes of the annual thyroid cycles in passerine birds, as a group, can emerge.

SUMMARY

A description of the annual cycle of thyroid activity in the White-crowned Sparrow (*Zonotrichia leucophrys gambelii*) of eastern Washington has been given. Thyroid activity, measured by a histological method, is high in autumn and winter, intermediate in spring, and low in summer.

The populations of the same race studied by Oakeson and Lilley (1960) elsewhere do not exhibit such a cycle. This suggests that the cycle exhibited by *Z. l. gambelii* in eastern Washington is caused by an environmental factor. Three lines of evidence suggest that this external factor is air temperature: (1) Thyroid activity of wild populations of *Z. l. gambelii* in eastern Washington was found to be closely correlated with the mean temperature of the preceding half-month. (2) Experiments showed that tem-

perature had an effect on thyroid activity of captive *Z. l. gambelii* sufficient in magnitude and direction to account for the cycle observed in nature. (3) The environment of the populations without a pronounced thyroid cycle differs most obviously from the environment in eastern Washington by the absence of a pronounced cycle of temperature.

Attention is drawn to the fact that the majority of passerine birds hitherto investigated do not give histological evidence of high thyroid activity in cold winters. Attention is also drawn to the great variation, among reports on various passerine species, concerning possible roles of thyroid activity during molt, reproductive activity, and migration.

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CLASSIFICATION AND EVOLUTIONARY RELATIONSHIPS OF THE SEA DUCKS

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When Delacour and Mayr (1945) revised the classification of the Anatidae, one of their major innovations was the erection of the tribe Mergini, the members of which had in the past (Peters, 1931) been included in the subfamilies Nyrocinae (=Aythyinae) and Merginae. This separation of the true pochards (*Netta* and *Aythya*) from the other diving ducks and the merging of the merganser group into the same tribe with the goldeneyes (*Bucephala*) and other sea ducks has been accepted by most authorities and incorporated into recent classifications such as those of Kagelmann (1951) and Boetticher (1952), although it still is not accepted by the A.O.U. Check-list (1957). However, the eiders, which until 1945 had been included without exception with the scoters (*Melanitta*), goldeneyes and other diving ducks, were only provisionally placed in the Mergini, since Delacour and Mayr pointed out that the eiders' tracheal anatomy and the pattern of their downy young differed from those of the other members of the Mergini.

Delacour and Mayr characterized the tribe Mergini as follows: They are mainly sea dwellers and consume primarily animal food, which is usually obtained by diving. Their bills are strong and hooked but extremely variable in shape. Their wings are generally short, the flight heavy, and walking on land is done with some difficulty. Many species nest in crevices or hollows, but a few nest on the ground. Males of most species are brightly colored and have distinct "eclipse" plumages, but metallic coloration is generally restricted to the head region. Sexual maturity is not reached before the second or third year, and even when mature most species are not particularly noisy birds. Males of nearly all species have elaborate displays, and most species are northern in distribution. The downy young tend to be boldly patterned with dark gray and white, usually having a distinctive "capped" head appearance. Delacour and Mayr suggested that the tribe's closest relatives might be the perching ducks (Cairinini), because of the similarities of these tribes in nesting habits and the long, broad tails found in many species of both groups. However, evidence from hybridization (Johnsgard, 1960*a*) indicates that these tribes are not closely related, which is also suggested by the differences in the downy young as well as behavioral differences (Johnsgard, 1960*b*).

The first major criticism of this proposed arrangement came from Humphrey (MS, thesis Univ. Mich.), who studied the tracheal anatomy of nearly all the members of the tribe, the only exception being that of the extinct Labrador Duck (*Camptorhynchus labradorius*). Humphrey found that the male tracheas of the included species fell broadly into two groups. In one of these, including all the eiders and the Harlequin Duck (*Histrionicus histrionicus*), the tracheas are relatively uniform in diameter throughout, and the tracheal bullae are completely ossified and rounded asymmetrically toward the left. Such a tracheal condition is also found in the shelducks and sheldgeese (Tadornini), dabbling ducks (Anatini), and perching ducks (Cairinini).

The rest of the tribe possesses tracheas which are more variable, but they tend to have tracheal tubes of varying diameters and tracheal bullae which are either rudimentary (scoters) or of rather complex shape and possessing membranaceous fenestrae (the rest of the tribe). Such a tracheal form is also found in the pochard group (Aythyini) and appears to be the highest degree of tracheal specialization in the entire Anatidae.

Humphrey (MS) concluded that the Mergini is actually composed of two "unrelated groups of birds, some members of which have independently evolved similar diving adaptations."

Humphrey agreed that the mergansers (*Mergus*) are closely related to the goldeneye group, and he accepted the generic classification of Delacour and Mayr with the single exception of the Steller Eider (*Polysticta stelleri*), which Humphrey believed should be retained as a monotypic genus apart from the typical eiders (*Somateria*). Humphrey did not decide whether the Harlequin Duck belongs with the eider group, which it resembles in tracheal structure, or with the rest of the sea ducks, which it resembles in nearly every other respect. He also did not indicate in which group he believed the Labrador Duck to belong.

In 1958, however, Humphrey supported the view that the eiders should be placed in a separate tribe "Somateriini," adjacent to the dabbling ducks (Anatini). The following characteristics of the eiders were given in favor of this separation: (1) the *Anas*-like tracheal structure of male eiders, (2) the *Anas*-like plumage patterns of female eiders, (3) the pattern of the downy young of eiders, which differs from the other sea ducks, (4) the belief that (p. 132) "eiders may take large percentages of plant foods while on the breeding grounds," (5) the use of the wings by eiders when diving and the leaving of them partly open when under water, as in most *Anas* species, and (6) the tendency of eiders to "tip-up" when feeding in shallow water. Delacour (1959) accepted Humphrey's proposals for the generic separation of the Steller Eider.

In defense of Delacour and Mayr's (1945) original classification, the opposing arguments should be mentioned here for each of Humphrey's points. The separation of the eiders on the basis of the trachea cannot be done without including the Harlequin Duck in the eider tribe, although on every other account it is more like the typical sea ducks. In addition, Wilson's (1829:370) description of the trachea of the Labrador Duck, not mentioned by Humphrey, suggests that it too has a bulla like those of the eiders, "bony, and round, puffing out from the left side," and a tracheal tube which is variable in diameter as in the other sea ducks and especially like those of scoters. The plumage of female eiders is admittedly *Anas*-like, as is the distinct speculum on the secondaries. However, this similarity in body plumage can in part be accounted for by the similarities of nesting habitats utilized by the two groups; thus similar selective pressures for disruptive coloration in females is operative. Yet the species which is presumably the closest relative of *Anas*, the Steller Eider, is actually more similar in plumage to females of the Labrador Duck, the scoters, and the Harlequin Duck, which latter also has a metallic speculum on the secondaries.

Although the young are certainly distinctive, downy eiders are not at all *Anas*-like, and indeed they are more like those of the scoters (especially *Melanitta nigra*) than any other group. There is little or no reason to believe that the eiders, which consume a higher proportion of animal food than many of the other sea ducks (Cottam, 1939), should suddenly switch to eating plant food during the breeding season when a high protein diet is essential for reproduction. This is certainly not true of eiders in captivity.

The use of the wings when diving is not a useful taxonomic criterion. Some species of *Anas*, mainly the larger species, normally do use their wings, whereas others, such as *Anas capensis*, rarely or never do so. That this is probably a function of the ratio between body mass and foot area is suggested by the fact that the large form of the Pintail (*A. acuta*) normally uses its wings while diving whereas the much smaller Kerguelen Pintail dives without opening its wings. Myres (MS, thesis Univ. B.C.) mentions that among the sea ducks the eiders, scoters, Old-squaw (*Clangula hyemalis*) and Harlequin open their wings and spread the alula, whereas the *Bucephala-Mergus* group dives with the wings tightly closed. Juvenal Common Eiders also dive with their wings closed.

Finally, the fact that eiders often tip-up in shallow water is of no significance whatsoever. I have observed species representing every tribe of Anatinae tip-up in shallow

water, including even the stiff-tail group (Oxyurini). Whether or not a species tips-up simply depends upon how deep the water is.

The second major investigation of the sea ducks has been that of Myres (MS, *loc. cit.*), which was entirely behavioral in scope. Myres was able to study 11 out of the 18 existing species and he obtained particularly useful and detailed information on the scoters and goldeneye-bufflehead groups. He did not, however, succeed in obtaining many first-hand observations on the genera *Polysticta* and *Mergus*. Myres' conclusions differ considerably from those of Humphrey. Myres found no evidence that the eiders are closely related to the Anatini. He states: "In female and pre-copulatory behavior characteristics, both Somateriini and Mergini are shown to be quite distinct from the Anatini. In female courtship behavior *Somateria* resembles some of the Aythyini and *Melanitta*." Myres found that female displays and displays associated with copulation are the only aspects of behavior sufficiently conservative to use in assessing generic and tribal affinities. In this respect the Old-squaw was found to be closely related to the scoters. The Bufflehead was found to be fairly distinct from the goldeneyes, possibly warranting generic separation from them, and also exhibiting some similarities with the scoters (Myres, 1959).

Myres did not observe a sufficient number of merganser species to compare them adequately with the goldeneye group, but he judged that they were probably closely related. Recent observations on the copulatory behavior of the Hooded Merganser (*Mergus cucullatus*) have proved the very close affinities between *Mergus* and *Bucephala* (Johnsgard, 1961). Myres (MS) states that in two behavioral respects, female "chin-lifting" and the long-soliciting prone posture before copulation, the eiders resemble the other sea ducks, but he indicated that these similarities might be the result of convergence. He concluded finally that "the relationship of the Somateriini to the Anatini is not indicated by their displays. The Mergini appears to be ancient and/or polyphyletic."

To summarize the situation, all investigators are in agreement that the *Bucephala-Mergus* assemblage is a valid one. This group has been separated by Boetticher (1952) and Kagelmann (1951) into an infra-tribal group, the "Mergeae," with the rest of the sea ducks being placed in the "Somatereae." Thus we have the following modern major arrangements of the sea ducks in existence:

Delacour and Mayr (1945)	Humphrey (MS; 1958) and Delacour (1959)	Myres (MS; 1959)	Boetticher (1952)
MERGINI	SOMATERIINI	SOMATERIINI	MERGINI
Somateria	*Somateria*	*Somateria*	SOMATEREAE
Camptorhynchus	*Polysticta*	*Polysticta* (?)	*Somateria*
Melanitta	MERGINI	MERGINI	*Camptorhynchus*
Histrionicus	*Melanitta*	*Camptorhynchus*	*Melanitta*
Clangula	*Camptorhynchus*	*Histrionicus*	*Histrionicus*
Bucephala	*Histrionicus*	*Clangula*	*Clangula*
Mergus	*Clangula*	*Melanitta*	MERGEAE
	Bucephala	*Charitonetta*	*Bucephala*
	Mergus	*Bucephala*	*Mergus*
		Mergus	

As part of a more general study on the behavior of the entire family Anatidae, based on the observation of 117 out of 143 living species of waterfowl at the Wildfowl Trust, Slimbridge, England, I have given some attention to this problem. I have been able to study in detail under wild conditions and/or in captivity 12 species of the sea ducks, including all the extant genera except *Histrionicus*. Courtship display has been observed in all 12 of these species, and copulatory behavior has been observed in 10 species. The behavior of these species will be reported on in detail at a later time, but a sum-

mary of my findings on the sea ducks has a bearing on these proposed classifications and will be presented here.

Since male courtship display is extremely adaptive and subject to selective pressures for divergence as a species-specific signal under conditions of sympatry with related species, it is of unquestionable taxonomic value only within genera. It is of interest, however, that in all the sea ducks studied to date two comfort movements occur during male display which are clearly ritualized and constitute homologous displays throughout the whole group. These are, in Myres' (MS) terminology, the "upwards-stretch" and the "upwards-stretch with wing-flapping." In the eiders these displays are very frequent and clearly function to exhibit the dark under parts. In *Somateria*, at least, the "upwards-stretch with wing-flapping" when used as a display is markedly different from this behavior when performed as a simple comfort movement (see McKinney, in Delacour, 1959). Likewise in *Polysticta* the "upwards-stretch" movement used during display is recognizably different from the normal body shake and is remarkably similar to the "upwards-stretch" of *Melanitta*. The "upwards-stretch" is also frequently performed by displaying Old-squaws, goldeneyes, Buffleheads, and mergansers. In the Buffleheads, the "upwards-stretch with wing-flapping" is particularly ritualized and is a major male display. In the Anatini, Cairinini and Aythyini the nearest thing to an "upwards-stretch" is the "introductory shake" (Lorenz, 1951–1953), which is performed uniformly alike by nearly all species in these tribes, and it is distinctly different in form from the "upwards-stretch" of the sea ducks.

Female behavior patterns are particularly useful in assessing relationships among the higher taxonomic categories. One female display, called "inciting" by Lorenz (1951–1953) is highly conservative and occurs in all tribes of the Anatinae with the single possible exception of the stiff-tail group (Oxyurini). In the sea ducks this behavior takes several markedly different forms, but in all it is equivalent in function and is almost certainly homologous in origin. In the eiders "inciting" has a marked chin-lifting comnent, alternating with threatening movements and calls. In the scoters only the chin-lifting component is present. "Inciting" has not yet been observed in the Harlequin or Old-squaw. In the goldeneyes there is no chin-lifting present, and the threatening movements are usually directed alternately to the two sides of the body ("jiving" of Myres, MS). In the Bufflehead the equivalent movement ("following" of Myres, MS) consists of rapid neck stretching and shortening, without the sideways threatening movements. In some of the mergansers "inciting" takes a curious form ("bobbing" of Hollom, 1937), in which the bill is primarily pointed downward rather than toward the side as the female energetically "leaps" forward through the water. In one species (*Mergus merganser*) this leaping component is present but there is also a distinct sideways pointing movement of the bill. The male response in all sea ducks, as well as in most other species of Anatinae, is the same, namely to swim ahead of the female while orienting the back of the head toward her (Johnsgard, 1960*c*). Of these types of "inciting," only that of the eiders is similar to "inciting" in females of other tribes, being most like that of the pochards (Aythyini).

All the sea ducks studied to date have similar pre-copulatory behavior patterns. The female assumes the receptive, or "prone," posture without mutual bathing or head-pumping display and remains in this position for a period ranging from a few seconds (as in Old-squaw and some scoters) to several minutes (eiders, goldeneyes and mergansers). The only other tribe where such a soliciting posture of the females occurs is in some species of perching ducks (*Cairina* and *Aix*). Before mounting, the male usually performs various displays that may be the same as the courtship postures or, more often, include ritualized comfort movements such as stretching, preening, and drinking. Similar

male pre-copulatory displays are found in a few perching ducks (*Aix*), and most if not all species of the pochard group perform mutual drinking and preening movements before the female allows the male to mount her.

During treading, males of several species of sea ducks vigorously flick their wings, producing a loud drumming sound which presumably has an auditory function. This has been observed in three genera (*Melanitta*, *Bucephala* and *Mergus*) only and is not known to occur in other tribes. In some sea ducks (*Somateria*, *Bucephala*, *Mergus cucullatus*) the male holds on to the female's nape for several seconds after copulation is completed, and the two birds "rotate" about a point. In these species the male "steams" rapidly away from the female after finally releasing her, turning his head mechanically from side to side. Similar rotary movements occur in some shelducks (Tadornini) and one perching duck (*Callonetta* = "*Anas*" *leucophrys*), but they do not occur in the Anatini or Aythyini. Post-copulatory "steaming" with head-turning is not found in any other group.

Although flight-intention movements would appear to have only limited taxonomic significance, the various duck groups are relatively well distinguished by these signals. Lateral head-shaking is a flight intention movement of most species of Anatidae, but it is of interest that the sea ducks studied thus far utilize only this type of flight signal. It is performed in association with an alert posture characterized by an erect neck, slimmed plumage, and a slightly up-tilted bill. In the Cairinini lateral head-shaking is combined with "pointing" movements of the bill (Lorenz, 1951–1953), whereas in the

Table 1

Comparison of Characteristics of Sea Duck Genera and of Other Related Tribes

	Somateria	*Polysticta*	*Camptorhynchus*	*Histrionicus*	*Clangula*	*Melanitta*	*Bucephala*	*Mergus*	AYTHYINI	ANATINI	CAIRININI
Consume animal food mainly	x	x	x	x	x	x	x	x	–	–	–
Nest in holes	–	–	?	x	–	–	x	x	–	–	x
Speculum nonmetallic	x	–	x	–	x	x	x	x	x	–	–
Mature 2nd or 3rd year	x	x	?	x	x	x	x	x	–	–	–[1]
Downy young well marked	–	–	?	x	x	x[2]	x	x	x	x	x
Tail long and broad	–	–	–	–	–	–	x	x	–	–	x
Female plumage disruptive	x	–	–	–	–	–	–	–	–	x	–
Tracheal bulla osseus	x	x	x	x	–	x[3]	–	–	–	x	x
Trachea varies in diameter	–	x	x	x	x	x	x[4]	x	x	–	–
Dive with wings open	x	x	?	x	x	x	–	–	–	x	x
"Upwards-stretch" male display	x	x	?	?	x	x	x	x	–	–	–
Female "inciting" display	x	x	?	?	?	x	x	x	x	x	x
Female prone posture	x	x	?	x	x	x	x	x	–	–	x[5]
Precopulatory drinking (♂)	–	–	?	?	?	x	x	x	x	–	x[6]
Precopulatory "upwards-stretch"	x	x	?	–?	–?	x	x	x	–	–	–
Precopulatory preening	x[7]	x	?	–?	–?	x	x	x	x	–	–
Copulatory wing-flick	–	–	?	?	–	x[8]	x	x[9]	–	–	–
Postcopulatory rotations	x	?	?	–	–	–	x	x[10]	–	–	–
Postcopulatory "steaming"	x	x?	?	–	–	–	x	x[10]	–	–	–
Head-shake only pre-flight signal	x	x	?	?	x	x	x	x	–	–	–

[1] Most species mature first year; [2] except *Melanitta nigra*; [3] bulla rudimentary; [4] except *Bucephala albeola*; [5] only in *Cairina moschata* and *Aix*; [6] only in *Aix*; [7] not always present; [8] not present in *Melanitta nigra*; [9] not present in *Mergus merganser*; [10] only in *Mergus cucullatus*.

"x" indicates presence of characteristic; dash indicates absence of characteristic.

Anatini faster neck-jerking movements occur along with lateral head-shaking (McKinney, 1953). In the Aythyini lateral head-shaking is accompanied by rapid and repeated chin-lifting movements.

These points concerning behavior are summarized in table 1, which also includes characteristics used by Delacour and Mayr (1945) in defining the group, as well as tracheal and diving characteristics utilized by Humphrey (MS) in his studies. Although numerous gaps still remain in our knowledge of the behavior of the sea ducks, enough information is at hand to make some objective comparisons among the genera of sea ducks and between the sea ducks and their possible closest relatives. By totaling the number of points in which various species or groups agree (20 possible) and disregarding those where the information is doubtful or absent, an index to similarity and probable phyletic affinities can be obtained. Such a tabulation is presented in table 2. From this table it can be observed that the genus *Somateria* agrees with the Anatini in nine out of 20 points (45 per cent), and *Polysticta* agrees with the Anatini in eight out of 18 points (44 per cent). *Somateria* agrees with the other sea ducks, excluding *Polysticta*, in 55 out of 95 points (58 per cent). *Polysticta* agrees with the other sea ducks (exclud-

Table 2

Table Illustrating Degrees of Similarity Among Genera of Sea Ducks and Other Related Tribes[1]

	Polysticta	*Camptorhynchus*	*Histrionicus*	*Clangula*	*Melanitta*	*Bucephala*	*Mergus*	AYTHYINI	ANATINI	CAIRININI
Somateria	15/18	4/6	6/13	10/16	13/20	11/20	11/20	6/20	9/20	6/20
Polystica		5/6	9/11	10/13	13/18	10/18	10/18	7/18	8/18	7/18
Camptorhynchus			5/6	5/6	6/6	4/6	4/6	4/6	2/6	2/6
Histrionicus				10/13	11/13	7/13	7/13	6/13	7/13	9/13
Clangula					14/16	10/16	10/16	10/16	7/16	7/16
Melanitta						14/20	14/20	11/20	8/20	9/20
Bucephala							20/20	9/20	2/20	7/20
Mergus								9/20	2/20	7/20

[1] Ratios were calculated from information presented in table 1.

ing *Somateria*) in 57 out of 84 points (68 per cent). This indicates that the eiders have their closest relationships with the other sea ducks rather than with the Anatini. Taking the sea ducks as a group, including the eiders, it is of interest to compare their degrees of similarity to the other tribes. Out of a total of 133 points, the sea ducks agree with the Aythyini and Cairinini in 62 points (47 per cent) and 54 points (41 per cent), respectively, and with the Anatini in 45 points (34 per cent). This would indicate that the sea ducks' closest relatives are not the Anatini but rather the Aythyini. Since the Anatini and Aythyini are clearly very closely related tribes, the sea ducks may have developed from very early Aythyini-like forms which still exhibited some of the characteristics (trachea, female plumage) of dabbling ducks.

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CONCLUSIONS

The eiders, although not altogether typical sea ducks, certainly show their closest affinities with that group, and the presence of intermediate forms represented by the Labrador Duck and perhaps also the Harlequin Duck makes it unwise, in my judgment, to divide the sea ducks into two tribes. Of the classifications available, that of Delacour and Mayr (1945) seems to me to be closest to reality, except that the Steller Eider undoubtedly warrants generic distinction from the typical eiders; in courtship and precopulatory behavior it exhibits closer affinities to the other sea ducks than does *Somateria*. I would propose the following sequence of genera: *Somateria, Polysticta, Camptorhynchus, Histrionicus, Clangula, Melanitta, Bucephala, Mergus*. Since these genera are all so well-marked I cannot accept Myres' (MS) opinion that the Bufflehead should be placed in a separate genus from the goldeneyes, although it does appear to provide a link between the goldeneyes and scoters.

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NESTING BEHAVIOR OF THE RUFOUS-SIDED TOWHEE IN COASTAL CALIFORNIA

By JOHN DAVIS

Despite the relative abundance and wide distribution of the Rufous-sided Towhee (*Pipilo erythrophthalmus*) in the western United States, the only major study of its breeding cycle in that area is the one recently published by Baumann (1959). Baumann described the entire cycle of a population of towhees at San Francisco, California, from the establishment of territory to the final independence of juveniles. The present study is restricted to the actual nesting behavior of a few pairs of towhees at the Hastings Reservation, northern Monterey County, California. Information on the singing behavior and gonad cycle of this population has been given in a previous paper (Davis, 1958).

MATERIALS AND METHODS

Observations were made on a few nests for long periods of time; this procedure resulted in a lack of information on certain aspects of the nesting program, but it allowed a quantitative approach to other aspects of nesting behavior which would otherwise not have been possible. Most of the observations are mine, but in addition the field notes of other workers at the Hastings Reservation have been used. Of special value was a long, careful series of notes taken by John A. Gray, Jr., on a towhee nest in 1939. This nest was elevated and could be seen by the observer; all the nests that I watched were placed on the ground and screened by surrounding vegetation.

Information on incubation and on the brooding and feeding of nestlings was derived from the following nests, which will be referred to subsequently by the numbers given here: Nest 1—observed by John A. Gray, Jr., for 70½ hours on 11 days between June 21 and July 8, 1939; Nest 2—observed by me for 232½ hours on 19 days between May 6 and 26, 1954; Nest 3—observed by me for 71½ hours on 10 days between May 26 and June 9, 1955; Nest 4—observed by me for 11½ hours on May 16, 17, and 19, 1956.

A total of 386 hours was spent observing these four nests. In addition, brief observations were made on the building of two nests. Since no nest went to completion, it was not possible to obtain information on the behavior of the young after departure. All references to time are Pacific standard time.

I take this opportunity to acknowledge gratefully the long-continued support of the program at the Hastings Reservation by Mrs. Russell P. Hastings which made possible both Gray's and my field work.

NESTING DATES

Nesting at the Hastings Reservation ordinarily starts in the last ten days of April. The earliest nest was found near the beginning of the incubation period on April 10, 1960; it contained a definitive clutch of three eggs. Building must have started in the first week of April. The next earliest evidence of nesting was recorded on April 27, 1939, when a nest containing four eggs was found. Building of this nest must have started prior to April 20. In the same year, a towhee was seen carrying nest material on April 21, and a female was seen carrying material on April 24. In 1946 one was noted carrying material on April 24, and in 1955 a female was seen with her bill full of coarse, dry grass on April 28. Additional information on the start of breeding was derived from specimens collected near the Reservation. Of four females collected on April 15, 1955, none was in breeding condition; two of three collected on April 27 had defeathered incubation patches and although they had not yet laid, indications were that laying would have

started within a few days. In 1956, a single female collected on April 12 had not yet reached breeding condition; of two collected on April 27 one had not yet reached full breeding condition and the other had already laid one egg.

The latest nest at the Reservation was found on June 28, 1941, at which time it contained three eggs. Thus, the major part of the breeding season is confined to a period of about two and one-half months. It is not possible to state whether nests found in June represented second nests or renesting by pairs which had attempted unsuccessfully to nest earlier in the season. The failure of all nests actually observed for long periods of time suggests that many, if not most, of the June nests represented renestings. Further, most of the juveniles observed during the summer months appeared to be at about the same stage of development, suggesting that most pairs raise only one brood at this locality. That some pairs may raise two broods is suggested by the collecting of a bob-tailed juvenile, perhaps two days out of the nest, on August 2, 1955. The situation is similar to that described by Baumann (1959:190) for towhees at San Francisco; of four pairs studied by him, three raised one brood, and one raised two broods.

NEST SITES AND MATERIALS

Of 25 nests found by various observers at the Hastings Reservation, 23 were placed in depressions in the ground so that the upper surface of the nest was either flush with the ground surface or projected slightly above it. It is not known whether the depressions in which nests were placed were natural or made by the towhees. Two nests were surrounded by unbroken oak leaf litter, suggesting that the nest depressions had been scratched out. Cohen (1899:62), describing the nesting of this species at Alameda, California, stated that "in all these ground-nesting cases the bird scratches a hollow in the sandy soil or leaf mould about an inch deep before bringing building material," but since the statement was not supported by any specific observation, it is difficult to know whether it was based on observation or assumption. Only two of the 25 nests at the Reservation were placed above the ground; one was 3 feet up in a tangle of coffeeberry (*Rhamnus californica*) and Nuttall bedstraw (*Galium nuttallii*) and the other was 18 inches up in California sagebrush (*Artemisia californica*).

Although most nests of the Rufous-sided Towhee throughout its western range have been found on the ground, there may be some variation among local populations in the location of the nest. Egg data slips in the Museum of Vertebrate Zoology for 12 California and one Nevada nest of this species from a total of 12 localities show that eight nests were placed from 2 to 6 feet above ground and only five were placed on the ground. On the other hand, data slips for a series of 11 nests collected near Fyffe, Eldorado County, California, show that ten were placed on the ground and one 2½ feet above ground, and of 11 nests found by Baumann (1959:184), ten were placed on the ground and one was 32 inches up in a bush.

It would seem that long series of nests from restricted localities show a great preponderance of ground nests; the data slips for 12 localities, previously referred to, may have shown a preponderance of elevated nests because such nests might be more easily found by casual collectors not concentrating on this one species. Of considerable interest is the statement of Cohen (1899:61) that in Alameda, from 1886 to 1892, he found "annually an average of eight sets and a few nests containing young. There were then approximately nine pairs of birds. . . . At that time the nests were placed on the ground with very rare exceptions, but owing to an army of cats that had become self supporting there were in 1898 only seven pairs . . . on the premises and nearly all the nests for the last five or six years were placed off the ground. . . . Having freed the premises from the cats by late spring, the Oregon Towhees began to build more on the ground. . . ." This

suggests that the Rufous-sided Towhee is primarily a ground nester but that a local population may change its nesting habits in response to abnormally high pressure from nest predators.

Nests at the Reservation were characteristically placed in relatively exposed situations and never deep within tangles or heavy thickets of brush. Most were found in grassy and/or leaf-littered areas at the edges of thickets or near isolated shrubs or trees so that overhanging branches might afford some shelter from above. Several nests were placed on the ground between the branches of fallen oak limbs. Since nests were flush with the ground, or nearly so, surrounding vegetation such as bracken (*Pteridium aquilinum*), tarweed (*Madea* sp.), common vervain (*Verbena lasiostachys*), or various grasses provided sufficient lateral screening.

Despite the relatively exposed situations in which nests were found, they were impossible to discover unless one followed a bird to the nest or accidentally flushed an incubating or brooding female. The relatively exposed sites of most nests had both advantages and disadvantages. Trips to and from the nest were made easily by the parents without their having to work through heavy vegetation; on the other hand, nests were frequently exposed to the sun and this entailed protection of the eggs or young by extensive incubating or brooding.

Nests showed a surprising uniformity of construction despite the variety of locations in which they were found. Of 12 for which some description has been set down, the outer supporting structure of 11 was composed of strips of bark, usually in combination with a few dead leaves and pieces of coarse, dry grass. Only one nest lacked bark strips in its outer portion. Nests that were examined closely were made of strips of inner bark, with only a few scraps or short strips of outer bark present. In one nest strips of the inner bark of willow (*Salix* sp.) were used and in another strips of the inner bark of poison oak (*Rhus diversiloba*). In both instances the materials were obtained nearby. The longest bark strip noted in any nest measured 11½ inches; most strips were about one-half inch wide.

The inner cups of all nests were composed of fine, dry grass stems. In one nest most of the stems had been nipped off at or near the base, and some of the stems bore roots. In this instance most of the stems contained dry seed heads, identified as soft chess (*Bromus mollis*), which were available near the nest. The largest stem was 13 inches long from root to seed head and had been neatly coiled into the walls of the compact lining. The materials used by the towhees at the Reservation were apparently identical to those used by the towhees studied at San Francisco by Baumann (1959:185).

Measurements of nests varied surprisingly little. The inner cups of three nests measused 3⅜ × 3¼, 3¼ × 3¼, and 3 × 3 inches, the birds achieving a nearly, or seemingly perfectly, circular cup in each instance. The inner cups of four nests were 2⅛, 2¼, 2¼, and 2½ inches deep. Outside diameters of three nests were 4¼ × 4¼, 4¼ × 4½, and 4½ × 4½ inches. The very narrow limits of variation of placement, materials, and size of nests at the Reservation suggest that the behavior patterns associated with nest construction have been selected for rather rigidly in this population.

NEST BUILDING

Nest building was observed in only two pairs, and in each the female gathered and placed all the material. One female was watched building a nest on the ground on May 5 and 6, 1955. On May 5, between 6:03 and 6:36 a.m., she made 12 trips to the nest, averaging one every 2.8 minutes. On these trips she carried large pieces of nest material, twice identified as bark, apparently for the outer supporting structure. She gathered this material about 25 feet from the nest. From 6:36 to 7:07 she remained away from

the nest; at 7:07 she resumed building. On May 6, she made 14 trips between 5:32 and 6:26 a.m., one every 3.9 minutes. On three trips the material that she carried was identified as coarse, dry grass. Observations were resumed at 6:54, and in the next 32 minutes she made seven trips, one every 4.6 minutes. From 7:28 to 7:32 she foraged, resuming work on the nest at 7:33, but after only one trip she joined her mate to scold a weasel passing through their territory between 7:36 and 7:46.

Resuming her building activity at 7:46, she spent two minutes gathering fine, dry grass stems 10 to 15 inches long, holding them by the middle so that when she flew to the nest at 7:48 they trailed back along the sides of her body. Between 7:48 and 7:59 she made four trips; twice she carried fine, dry grass, and once, two pieces of limp, gray, weathered grass. The change in the nature of the materials being used since 7:46 suggested that she was now working on the inner lining. Between 7:59 and 8:25 she did no building, and at 8:25 I searched for the nest. Although I had seen her make a number of trips, it took me five minutes to locate the nest, so well was it hidden. It seemed complete save for the bottom of the inner cup, which had just been started. Between 5:15 and 6:00 p.m., she made two trips, carrying fine, dry grass on one, and a mixture of fine and coarse dry grass on the other.

On May 7, no trip was made between 8:53 and 9:45 a.m., and when I visited the nest neither member of the pair was in sight. The nest at this time appeared to be complete; it had been soaked by intermittent rain falling earlier in the morning. I placed a small twig in the cup; on the following day, May 8, it had been removed, indicating that the nest had at least been visited, if not worked on. The nest was completely dry at this time. On May 10 no bird visited the nest between 4:00 and 6:00 p.m., and on May 11, the first egg was laid. Construction of this nest took at least two days.

Another nest under construction (Nest 3) was located on May 21, 1955. At 8:45 a.m. I found the female carrying coarse, dry grass. From 8:55 to 9:34 she made three trips, carrying long, fairly fine dry grass; this was held in the middle in the same fashion as the female at the first nest. The nature of the material being carried suggested that work had just started on the inner cup. No further trip was noted between 9:34 and 11:05 a.m., or between 3:06 and 5:15 p.m. When the nest was next examined at 7:17 a.m. on May 23, two eggs were present, so that the nest must have been completed on May 21 or early on the 22nd at the latest.

The males of both pairs took no part whatsoever in gathering materials or in building. The male of the pair watched on May 5 and 6 never accompanied his mate while she gathered material and carried it to the nest, nor did he come close to the nest at any time. He spent a great deal of time singing, often out of sight of his mate. Occasionally, when the female left the nest, she would join him, sometimes after he had called but more often while he was singing. Infrequently the male flew to the female after she had left the nest, but when she then left him to gather material, he did not follow her. The male of the pair watched at Nest 3 on May 21 behaved in the same manner. Thus, at the two nests where brief observations were made, the males not only took no part in nest building, but they made no effort to stay near their mates or nests.

CLUTCH SIZE AND EGG LAYING

Clutch size over the western part of the range of the species ranges from two (Baumann, 1959:190) to six (Cooper, 1870:242), with the great majority of clutches being of three or four eggs. Fifteen nests found at the Hastings Reservation either contained young or had been watched over a period long enough to determine the end of egg laying. Of these 15, one contained two, six contained three, seven contained four, and one contained five eggs or young. The pitfalls present in accurately determining clutch

size are exemplified by Nest 3, in which the female laid the last of five eggs on May 26. Between the evening of June 2 and the early morning of June 4 one of the eggs disappeared and no trace of it was ever found. An observer discovering this nest on June 4 would have assumed a four-egg clutch. In the light of this experience, reports of two-egg clutches should be viewed with suspicion. It is not possible to state how often errors of this nature have influenced reported clutch size in this or other species. In the present instance, one can say only that 13 of the 15 nests found at the Hastings Reservation contained either three (6 nests) or four (7 nests) eggs or young, and that the population agrees in clutch size with the figures reported over the western range of the species.

In two nests in which egg laying was followed, eggs were laid one a day on successive days until the clutch was complete. Eggs appeared to be laid in the morning. In one nest, the first egg was laid between 5:30 p.m., May 10, and 12:46 p.m., May 11. The third egg was laid between 4:35 p.m., May 12, and 11:35 a.m., May 13, and the fourth and last egg was laid between 6:20 and 9:48 a.m., May 14. In Nest 3, the third egg was laid between 5:45 p.m., May 23, and 9:40 a.m., May 24, the fourth between 5:25 p.m., May 24, and 11:30 a.m., May 25, and the fifth between 7:27 and 10:16 a.m., May 26.

The length of time elapsing between the completion of the nest and the laying of the first egg was determined in two cases. One nest was completed on May 7, and the first egg was laid four days later, on May 11. At Nest 3, the female was still building on May 21. When the nest was next visited, early on the morning of May 23, it contained two eggs, one apparently laid on May 22 and one on May 23. It appeared as though the nest had been completed on one day and that laying had started on the next. The late date of completion of this nest may have accounted for the lack of a waiting period prior to the start of egg laying.

Copulation was seen only once, on May 6, when the female involved was still building her nest. In this instance, copulation preceded the laying of the first egg by five days. Baumann (1959:186–187) reported copulation involving a nest-building female.

During the laying period, females apparently visit the nest and manipulate the eggs. This was suggested by the shifting in position of marked eggs in one nest before the clutch had been completed and incubation started.

INCUBATION

Length of period.—The exact incubation period was established only at Nest 3, in which all eggs were marked. On May 23, 1955, this nest contained two eggs; both were marked "1." Eggs were laid, one each day, until the clutch of five was complete on May 26, the last egg having been laid between 7:27 and 10:16 a.m. on that date. One of the first two eggs later disappeared and no trace of it was found. At 10:19 a.m., June 7, the remaining egg "1" and eggs "3" and "4" had hatched; the last egg laid, "5," hatched between 11:55 a.m. and 3:22 p.m. The incubation period at this nest, from the laying of the last egg to hatching of same, was between 12.07 and 12.33 days.

Linsdale (MS) found a nest containing two eggs on June 2, 1941. On June 3, three eggs were present. At the next visit, on June 7, the female was incubating four eggs. Assuming a laying rate of one egg a day, the clutch would have been complete on June 4, and incubation would have started on that date. On June 15, three of the eggs had hatched. If the last egg had hatched later in the day, the incubation period would have been about 12 days. Baumann (1959:196) reported incubation periods of 14 and 13 days for two nests at San Francisco, although the date of April 12 given for the beginning of incubation for the 14-day nest should have been April 20 (*op. cit.*: 186). Although the samples of two nests at each locality are far too small to support any con-

clusions, there is a suggestion that the incubation period is somewhat shorter at the Hastings Reservation.

Sessions on nest.—At every nest, incubation was performed only by the female. The only possible exception to this was at Nest 2, to which the male made a visit of 15 minutes at a time when it was not known whether the female was present or not. If the male actually incubated during this period, and this seems very doubtful, his attendance during 120.5 hours of observation would have been 0.21 per cent.

Incubation apparently starts with the completion of the clutch. At Nest 3, in which five eggs were laid, the female was absent between 5:08 and 7:27 a.m., May 26, at which time four eggs were present. Between 7:27 and 11:48 she was on the nest 74.5 per cent of the time, and when the nest was checked during her absence at 10:15, five eggs were present. Heavy incubation continued until hatching.

At Nest 2, eliminating partial off and on periods, the mean attendance during 92.5 hours of observation on nine days between May 5 and 15, the day before hatching, was 76.8 per cent. At Nest 3, attendance based on similar data for 30.5 hours of observation on seven days during the entire incubation period, May 28 to June 6, was 81.4 per cent. At Nest 1, at which hatching occurred on June 30, attendance for entire on-off cycles aggregating 485 minutes on June 21, 24, and 26, was 77.8 per cent. At no nest was any particular trend in attendance noted as the incubation period progressed.

Table 1

Attendance of Incubating Female in Relation to Temperature

Date	♀ Attendance (per cent)	Obs. period (minutes)	Max. temp. (°F.)	Min. temp. (°F.)	Av. temp. (°F.)
		Nest 2			
May 6, 1954	66.1	636	87	51	69.0
7	76.5	729	81	43	62.0
8	75.4	898	76	47	61.5
10	81.1	851	63	46	54.5
11	78.4	660	74	37	55.5
12	74.0	856	71	35	53.0
13	73.7	686	77	40	58.5
14	80.6	841	80	35	57.5
15	78.2	904	70	46	58.0
		Nest 3			
May 28, 1955	81.2	493	80	48	64.0
30	82.8	552	83	38	60.5
June 1	75.6	265	59	29	44.0
2	78.4	451	68	39	53.5
4	82.6	567	87	53	70.0
6	83.0	542	91	55	73.0

Daily attendance figures show no consistent correlation with temperature (table 1). At Nest 2, there was an inverse correlation between attendance and temperature on the days of highest and lowest maxima, attendance being lowest on the day of highest maximum (May 6) and highest on the day of lowest maximum (May 10). Between these extremes, no correlation is apparent. The only correlation with minimum and average temperatures occurred on May 6, when lowest attendance coincided with highest minimum and average temperatures. Exactly the reverse is shown at Nest 3. Here, the three days of highest attendance occurred on the three days of highest maximum tempera-

tures, and the three days of lowest attendance coincided with the lowest daily maxima. The days of lowest and highest minima coincided with the days of lowest and highest attendance. The two days of lowest attendance coincided with the two days of lowest average temperature, and the day of highest attendance coincided with the day of highest average temperature. It is obvious that nests 2 and 3 were diametrically opposed with regard to correlation between attendance and temperature, and no conclusions can be drawn on the basis of this small sample.

At Nest 2, 115 on periods and 115 off periods averaged 37.0 and 11.2 minutes, respectively. At Nest 3, 32 on and off periods averaged 46.5 and 10.6 minutes, and at Nest 1, ten on and off periods averaged 36.4 and 12.0 minutes. The overall averages for these 157 periods are 38.9 and 11.1 minutes. It will be noted that on periods were nearly identical for nests 1 and 2, and considerably longer for nest 3. However, the average off periods for all nests were nearly similar. As can be seen (table 2), the length of 147 off periods was not correlated with the length of the preceding on periods. Regardless of length of the preceding on period, off periods averaged between 10.5 and 11.8 minutes. The ranges and coefficients of variation for the three different classes of off periods are remarkably similar.

Table 2

Relation of Off Period to Preceding On Period during Incubation[1]

Range of On Period	0–20	21–40	41 and over
Number	24	65	58
Mean On Period	14.9	29.6	58.0
Off Period			
Mean	11.0	10.5	11.8
Standard error	0.87	0.51	0.59
Range	3.0–20.0	3.5–24.0	4.0–26.0
Coefficient of variability	38.9	39.1	37.8

[1] Combined data from nests 1, 2, and 3, expressed in minutes.

On and off periods showed no regularity or rhythm. Very long or very short periods could occur at any time of day. In view of the greater consistency of off periods as compared to on periods, it seems probable that desire to return to the nest, probably increasing as time passes during an off period, constitutes a stronger stimulus than hunger or whatever factor or factors impel the female to leave the nest.

Behavior.—At nests 1, 2, and 3 the females showed a definite tendency to use a particular approach when returning to the nest after an absence. At Nest 1, which was three feet above ground, the female usually flew to a point about six feet up in an adjacent live oak, thence to the nest shrub at a point above the nest, and then she dropped down to a point below the nest and worked up to it. She usually entered the nest from the south side. The habit of perching above and then below the nest, and then working up to it, was invariable. At Nest 2, the female nearly always flew to the thicket immediately west of the nest; if approaching from the east, she would pass beyond the nest to the thicket. In either case, she would then work back through the thicket to a takeoff point near the nest from which she would fly down to resume incubation. She used two takeoff points indiscriminately, one on a strand of barbed wire and the other on a branch of a poison oak paralleling the wire and nearly touching it. Both points were 35 inches from the nest. Examination of the branch of the poison oak after the nestlings had disappeared revealed an area 3 inches long on which the outer bark had been worn away by the female's repeated takeoffs. At Nest 3, the female showed somewhat greater variety in the early stages of her approach to the nest. She would

invariably fly to a large live oak near the nest, landing from five to 20 feet up on the side of the tree away from the nest. She would then work down and around until she was on a branch or an intertwining poison oak vine from one to five feet up on the side of the tree nearest the nest. From here she would always fly down to a fallen limb immediately adjacent to the nest, hop down, and resume incubation.

The only observations of the female on the nest were made by Gray at Nest 1. This female seemed alert at all times, turning her head to peer toward Scrub Jays (*Aphelocoma coerulescens*) calling nearby and occasionally looking toward her mate when he sang or called near her. Infrequently she would stand up and lower her head, apparently working on the nest or moving the eggs, sometimes stretching her wings and ruffling her plumage as she rose. She was almost entirely silent when incubating, calling from the nest only four times in 13½ hours of observation.

At Nest 3, in which all eggs were marked, I visited the nest several times during absences of the female. It was apparent that the eggs had been shifted in position in the course of the preceding incubating period, but such shifting was purely random and there was no evidence of any regular rotation.

When leaving the nest, females showed considerable variation in the direction of their departure. Sometimes this was determined by the location of the male. Females would sometimes fly toward the male if he were singing or calling, or if the male were silent when the female left the nest, she would sometimes fly toward the area in which he had last sung or called. There were many cases, however, in which the female would fly in some other direction. At Nest 2, regardless of the whereabouts of the male, the female many times flew to the crown of a large live oak upslope from the nest, stretching her wings and ruffling her plumage on alighting. She would then forage through the dense crown of the oak, moving through the crown toward the upslope side, where I would lose sight of her. She took this route frequently even though the male might be calling or singing from some other direction. After leaving the nest the female usually called several times, apparently informing the male of her whereabouts. Usually, the male was either calling or singing when the female left the nest, so that she was aware of his location. Thus, within a short time after the departure of the female, each member of the pair had located the other.

The reactions of the male to the departure of the female from the nest may be judged in part by the nature of his behavior immediately before and after her departure. This was noted for 108 flights from the nest by the incubating female at Nest 2 (table 3). In 39 instances the male's behavior changed, and it seems likely that these changes resulted from his seeing the female leave the nest. In 69 instances no change in behavior was noted, with one qualification. A few times when the male sang both before and after the female left the nest, he broke his steady singing, which normally was at intervals from 4 to 7 seconds, with an interval of 15 to 20 seconds just after the female flew; he then resumed steady singing. It seemed likely that he had seen his mate leave the nest in these instances. But usually he gave no evidence that he was aware that the female had left the nest. He showed no tendency to join her, nor did she show any particular tendency to join him. A few times the male joined his mate shortly after she had left the nest, but such behavior was rare. Baumann (1959:193) stated that the male remained near enough to the nest in the absence of the female so that he could keep it under surveillance, but this was not true of the male at Nest 2. I visited this nest a number of times in the absence of the female without drawing the attention of either member of the pair.

In only 37 of 108 cases was the male silent immediately after the female flew from the nest (table 3), but sooner or later he would call or sing before she resumed incuba-

Table 3

Behavior of Male Before and After Incubating Female Left Nest 2

Behavior before	Behavior after	Number
Calls	Silent	5
Calls	Sings	4
Sings	Silent	15
Sings	Calls	1
Silent	Calls	3
Silent	Sings	11
		39
Calls	Calls	4
Sings	Sings	48
Silent	Silent	17
		69

tion. In the other 71 instances the female knew the whereabouts of her mate at the time she left the nest. Thus, each member of the pair was usually aware of the location of the other member, although there appeared to be no well-marked tendency for them to stay near each other when the female was not sitting. The impression that I received was of a rather casual relationship with the members of the pair keeping in touch with each other without frequent contact, a situation similar to what has been previously described for nest building.

When the female returned to the nest, in nests 1 and 3 as well as in Nest 2, she almost invariably called on her return flight, apparently informing her mate that she was returning to the eggs. Sometimes such calling was confined to the beginning of the return flight, but often the female would call a few times from the takeoff point just before dropping down to the nest. At Nest 2, the male rarely accompanied his mate on her return trip. Indeed, on several occasions, the returning female was attacked by a Brown Towhee (*Pipilo fuscus*) which apparently had a nest nearby. Despite the loud alarm calls of the female when attacked, and the loud sounds of the chase as it proceeded through the thicket adjacent to the nest, the male never appeared to aid his mate.

Only twice did the male at Nest 2 seem to lose track of the female; this occurred when he made single trips to the nest with food in the absence of the incubating female, on May 12 and 14. However, Nolan (1958:264) found that male Prairie Warblers (*Dendroica discolor*) brought food to the nest during the incubation period, "largely or wholly without regard to whether the female happens to be on her nest at the time," and the same may be true of the Rufous-sided Towhee.

It is difficult to determine whether or not the female left the nest in response to the singing or calling of the male. Unlike the Song Sparrow (*Melospiza melodia*), which has a special "signal song" to which the incubating female responds (Nice, 1937:126), the Rufous-sided Towhee lacks such a special song. There were a few cases of the female leaving the nest immediately after the male had called or sung, and in these one might say that the male had called the female from the nest. In the great majority of cases, however, there was no such immediate response by the female and it was impossible to decide whether she had left the nest independently or not. For example, if the male started to sing after a silence of 15 minutes, and the female left the nest after he had been singing for five minutes, did this represent a response of the female to the male, or not?

While the female was incubating at Nest 2, the male either sang, or called, or was silent. Most of his time was spent in silence; the next greatest percentage of his time

was spent in singing; and only a small fraction of his time was spent in calling. Table 4 shows the number and duration of periods of calling, singing, or silence that preceded 122 departures of the female during incubation at Nest 2.

She left the nest most quickly in response to the calling of the male. In 14 of the 16 instances recorded, the male called between 0.5 and 1.0 minute before the female responded; twice, he called for three minutes before she left the nest. It seems likely that in 14 instances, and possibly in all 16, the male actually called the female from the nest. The small percentage of cases in which calling immediately preceded the female's departure from the nest is a reflection of the slight amount of calling that this male did. However, the short time that elapsed between the inception of calling and the departure of the female suggests that the male actually summoned the female, although infrequently, by calling. This agrees with the observation of Baumann (1959:193), that the male occasionally called the female from the nest by use of the call note.

Table 4

Duration of Male Behavior Preceding Departure of Incubating Female from Nest 2

	Number	Range	Mean	Standard error
Calling	16	0.5–3	1.44	0.22
Singing	68	0.5–20	4.43	0.46
Silence	38	0.5–42	11.07	1.47

The effectiveness of singing as a signal to the female is far more difficult to assess. Here the lag in response of the female to the singing of the male ranged from 0.5 to 20 minutes. For the minimum value it appeared as though the female had responded to the male's singing; for the maximum lag, she definitely did not. Between these two extremes every lag in response between 1 and 9 minutes occurred, as well as lags of 11, 12, 14, and 16 minutes. It is impossible to establish a point below which it may be said that the female responded to the singing of the male and above which she did not.

Although it is not possible to determine this point, it can be said that if the female does leave the nest in response to the singing of her mate, song is a far less effective signal than calling, as the mean time lapse between the beginning of song and the departure of the female from the nest was over three times as long as the mean time lapse in calling. The difference between these means is significant (table 4), and the mean incubation period preceding the departure of the female in response to the calling of the male (31.3 minutes for 15 periods) was shorter than the mean incubation period preceding her "response" to his singing (39.2 minutes for 65 periods).

Finally, we may consider silence as a stimulus to the female to leave the nest. Silence on the part of the male would result in the inability of the female to locate her mate unless she could see him from the nest. Indeed, if the male were silent and out of sight, the female would not know if he were still on territory, or even alive. Since the male at Nest 2 called or sang frequently enough so that prolonged silences did not occur often, one might assume that only a relatively prolonged silence would be effective in causing the female to leave the nest, her tension presumably mounting over a period of time until it had reached a point at which she would fly in search of her mate. The mean time elapsing between the male's becoming silent and the female's leaving the nest was 11.07 minutes, almost eight times as long as the mean male calling period preceding her departure and about two and one-half times as long as the mean singing period (table 4). Silent periods preceding the departure of the incubating female ranged as low as 0.5 minute (1 case), 1 minute (3 cases), and 2 minutes (3 cases). It is possible that in these instances the female left the nest independently or in response to the calling or

singing that had immediately preceded these brief silent periods. Nonetheless, these short intervals of silence are included with the longer silent periods as they represented the behavior of the male immediately prior to the departure of the female from the nest. However, it is obvious that the same difficulties are inherent in evaluating the efficacy of silence as a stimulus inducing the female to leave the nest as are inherent in singing. The periods of silence of the male preceding the departure of the female from the nest ranged from 0.5 to 42 minutes, with all gradations between, and it is not possible to designate a particular interval of silence above which the female will respond.

When a female returns to the nest after an absence, she is probably influenced by conflicting stimuli. First, psychological attachment to the nest would tend to insure her presence there. Other factors, such as inclement weather or the presence of a predator near the nest, would tend to intensify this stimulus. Second, opposing stimuli arising from discomfort such as hunger, thirst, or cramped position, or from anxiety over the whereabouts of the male, would tend to make the female leave the nest. Assuming mild climatic conditions and the absence of an enemy near the nest, attachment to the nest must be strong when the female resumes incubation after an absence. The discomfort and anxiety factors must be low; certainly they would have been low in the case of the female at Nest 2, as she always foraged and communicated with her mate during her absences from the nest.

As time passed after her return, however, we might expect a decreased intensity of the nest attachment stimulus and increased intensity of the discomfort stimulus, and if the male were silent, increased intensity of the anxiety stimulus as well. At some point in time, the discomfort and/or anxiety stimuli must equal the intensity of the nest attachment stimulus. From this point on, the female would presumably be ready to leave the nest. If the male began to call or sing at this point or shortly thereafter, the female would probably leave the nest. If the female had not reached the point at which the opposing stimuli were roughly equal in intensity, calling or singing would probably be ineffective.

There were many more instances of calling and singing which were ignored by the female than instances in which she responded. Even in the case of the Song Sparrow, the female frequently does not respond to the "signal song" of the male but leaves the nest independently. Nice (1937:126) states that, in response to the "signal song" of the male, "the female often comes off the nest at once, but sometimes she merely answers with *ee-ee-ee* and remains; she may come off within a few minutes or stay until a second signal song some time later; or she may come off with no reference to her mate." One may wonder how effective this signal really is. The point at which calling or singing comes in relation to the intensities of the stimuli impinging on the female is obviously of paramount importance.

With regard to silence, since it must operate over a rather prolonged period of time to be effective, its inception may occur at a point of time shortly after the female had returned to the nest. There would be considerable opportunity for the male to break his silence, however briefly he might sing or call, before the discomfort and/or anxiety stimuli overrode the nest attachment stimulus. If the male's silence is sufficiently prolonged, it is conceivable that it will augment the anxiety stimulus to the point at which the female would leave the nest earlier than if the male had been vocalizing. The necessity for a period of silence to be prolonged to be effective may explain why silent periods preceded the departure of the female from the nest in only 38 cases as compared to 68 cases in which singing preceded her departure, although the male spent a greater part of his time in silence than in singing.

Anticipatory food bringing.—In 120.5 hours of observation at Nest 2 during the

incubation period, the male made a total of 15 trips to the nest. These aggregated 21.6 minutes and included one visit of 15 minutes during which it was not known whether or not the female was at the nest. The remaining 14 visits averaged 28.2 seconds long, ranging from 10 seconds to two minutes. On nine of these, the male carried food to the nest while the female was present; after eight visits he left the nest with his bill empty, and after one it could not be seen whether or not his bill was empty. On three visits the male came to the incubating female but it could not be seen whether or not he carried food. On one of these trips he wiped his bill after leaving the nest, behavior which suggested that he had been carrying food. Twice he brought food to the nest in the absence of the female, once leaving empty-billed and once still carrying the food with him.

At Nest 3, the male made only three trips to the nest in 54 hours of observation during the incubation period from May 26 to June 6. On May 30, he brought food to the female and remained at the nest for 35 seconds; on June 4, he brought food to the nest while the female was absent, and he remained for two minutes; and on June 6, the day before hatching, he came to the female on the nest and remained for 45 seconds, but it could not be determined whether or not he brought food.

Table 5

Anticipatory Food Bringing by Male at Nest 2

Date	Female	Male arrives	Male stays	Male leaves
May 8, 1954	on	with food	120 sec.	no food
10	on	with food	30 sec.	no food
11	on	?	20 sec.	no food
	on	with food	30 sec.	no food
	on	with food	30 sec.	no food
12	on	with food	20 sec.	no food
	on	with food	20 sec.	no food
	off	with food	10 sec.	with food
	(?	no food	15 min.	no food)
13	on	with food	15 sec.	?
14	off	with food	15 sec.	no food
	on	with food	30 sec.	no food
	on	?	15 sec.	no food
15	on	with food	20 sec.	no food
	on	?	20 sec.	no food

The incidence of the male's 15 trips to Nest 2 is summarized in table 5. There was an absence or low incidence of such trips between May 5 and 10 and a noticeably increased incidence in the last six days of the incubation period, from May 11 to 16. At Nest 3, two of the male's three trips occurred in the last three days of incubation. Nolan (1958:269–270), discussing anticipatory food bringing by male Prairie Warblers, presented considerable evidence that it is through this activity that the male learns of the hatching of the young, and anticipatory food bringing may serve the same function in the Rufous-sided Towhee.

BROODING

Brooding was performed at every nest by the female only. At all nests, the male sometimes spent several minutes at the nest when delivering food to the young in the absence of the female. At nests 2 and 3 it was not possible to see whether or not the male brooded at such times. At Nest 1, which was visible to the observer, the male occasionally spent periods up to eight minutes long at the nest in the absence of the female, perching on the rim for several minutes after delivering food to the young, but he never actually settled to brood them.

There was a decided difference in the amount of brooding that was undertaken at nests 1, 2, and 3. Because of the trend toward decreasing attendance as the nestling period progressed, average figures mean little and it is necessary to compare the nests on a day to day basis relative to the day of hatching. It can be seen (table 6) that attendance was far higher at Nest 2 than at Nest 1 when equivalent days are compared, for the first eight days after hatching day. Nest 3, for which data are available only for hatching day and the second day after hatching, appears to be more nearly similar to Nest 2 than to Nest 1 as regards attendance.

Table 6

Female Brooding Attendance

Date	Obs. period (minutes)	Attendance (per cent)	Max. temp. (°F.)	Min. temp. (°F.)	Average temp. (°F.)
		Nest 1			
		Hatching, June 30			
July 1	360	51.1	85.0	40.0	62.5
2	540	48.9	76.0	45.0	60.5
3	480	46.4	70.0	42.0	56.0
4	540	30.0	75.0	50.0	62.5
5	120	30.8	75.0	50.0	62.5
6	480	24.0	69.0	40.0	54.5
7	420	11.0	82.0	46.0	64.0
8	318	3.8	88.0	52.0	70.0
		Nest 2			
		Hatching, May 16			
May 17	861	80.6	88.0	52.0	70.0
18	687	88.6	93.0	52.0	72.5
19	867	68.0	87.0	42.0	64.5
20	698	70.4	78.0	37.0	57.5
21	854	63.1	76.0	36.0	56.0
22	898	54.9	78.0	42.0	60.0
24	855	21.1	76.0	47.0	61.5
25	669	11.6	76.0	39.0	57.5
26	246	0.0	65.0	35.0	50.0
		Nest 3			
		Hatching, June 7			
June 7	247	72.3	86.0	52.0	69.0
9	475	75.7	92.0	50.0	71.0

At nests 1 and 2, the amount of daily attendance by the females showed an almost steady decrease as the nestling period progressed. This trend was more even at Nest 1. The noticeable drop in attendance between the third and fourth days after the hatching day at Nest 1 was not evident at Nest 2. The only point of similarity between the two nests was the general decrease in attendance as the nestling period progressed.

The difference in attendance at nests 1 and 2 during the first six days after hatching day is not correlated with differences in the daily temperatures prevailing at each nest during this period (table 6). Part of the difference undoubtedly lies in the fact that Nest 1 was shaded at all times, whereas Nest 2 was in full sun from about 11:30 a.m. to about 1:30 p.m. This led to lengthy periods of attendance at Nest 2 during the middle part of the day, whereas such lengthy periods were not evident at Nest 1. Further, Nest 1 contained four nestlings and Nest 2 only two, so that there was much greater pressure on the female at Nest 1 to do less brooding and more feeding. The nearly similar

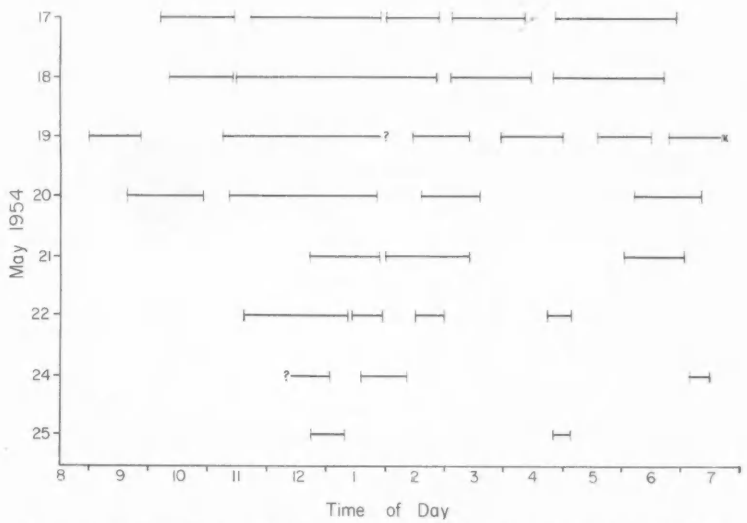

Fig. 1. Brooding periods of 15 minutes or more from 8:30 a.m. to the end of the daily observation period at Nest 2, May 17 to 25, 1954. Question mark (?) indicates that the exact beginning or end of a brooding period was not known; the symbol "X" indicates that the female was still brooding when observations ended.

attendance figures at Nest 1 during the seventh and eighth days after hatching day as compared to Nest 2 on the eighth and ninth days after hatching day undoubtedly reflect the decreased attendance at Nest 2 during the middle portions of those days.

As opposed to incubation, during which periods on and off the nest showed no regularity or rhythm, certain trends were evident in the brooding program at Nest 2 (fig. 1). During the first five days after the hatching day there was a definite tendency for the female to brood heavily from late morning to early afternoon, when the nest was in full sun, and again in the late afternoon. On the sixth, eighth, and ninth days the tendency to brood heavily during the middle of the day continued, and on those three days it was only during this period that any appreciable amount of brooding was done. The only period during which the nestlings were brooded on all days of observation was from 12:16 to 12:34 p.m. (fig. 1), another suggestion that the young were in special need of protection from the sun at about midday. Since there was no particular tendency during incubation to cover the eggs at that time of day, it would appear as though the nestlings were more endangered by direct sun than were the eggs. The obvious decrease in brooding during the middle part of the eighth and ninth days after the hatching day suggests that direct sun was not as dangerous to the nestlings during those days, when some degree of thermoregulation had apparently been achieved.

Because of the steady decrease in brooding as the nestling period progressed, it is not feasible to calculate average on and off periods. It is also difficult to determine whether there was any correlation between length of an on period and the length of the following off period. Using the first six days of the nestling period at Nest 2, when attendance figures were comparable to the attendance figures recorded during incubation, and considering only complete on and off cycles, 16 on periods averaging 30.9

minutes were followed by off periods averaging 13.9 minutes, and 18 on periods averaging 92.3 minutes were followed by off periods averaging 22.4 minutes. Unlike incubation, there appeared to be a tendency for the length of off periods to be influenced by the length of the immediately preceding on periods, but the average difference between off periods just noted is not statistically significant.

At Nest 1, when the male came to the nest with food while the female was brooding, she sometimes left the nest, thus exchanging with the male. At other times she would merely back off the young or move to one side, allowing the male to feed the nestlings, and she would resume brooding after he had left. In most instances when the male arrived at the nest shortly after the female had resumed brooding following an absence, the female would remain at the nest rather than exchange with the male. At Nest 2, during the first five days of the nestling period, when attendance by the female ranged from 63.1 to 88.6 per cent, the female exchanged with the male only after mean daily brooding periods ranging from 50.2 to 104.0 minutes, regardless of how many visits the male might make to the nest during such brooding periods. Between the sixth and ninth days, when her attendance ranged from 54.9 to 11.6 per cent, the mean daily brooding periods preceding exchange with the male ranged from 11.3 to 7.1 minutes. In other words, as the nestling period progressed, the attachment of the female to the nest decreased considerably, and her threshold of response for exchange with the male became noticeably lower.

TEMPERATURES IN NEST

At Nest 4, in which two nestlings hatched on May 15 and two on May 16, temperature readings were made on May 16, 17, and 19, by means of a constantan-copper thermocouple inserted through the bottom of the nest so that it was in contact with the undersides of the lowest nestlings. While the female brooded, the temperature at the bottom of the nest cup ranged from 73.4° to 77.9°F., although ambient air temperature two feet above the nest ranged from 42.8° to 60.8°F. When the young were unattended and the air temperature was 72.5°, the nest temperature was 75.2°; when the air temperature was 42.8°, the nest temperature fell to 60.8°. Thus, the brooding of the female kept the temperature at the bottom of the nest cup within narrow limits, but in the absence of the female, the nest temperature fluctuated in relation to the air temperature.

FEEDING

Observations on feeding were difficult to make except at Nest 1, as on many occasions it was not possible to see whether or not an adult actually carried food in its bill as it went to the nest. Even at Nest 1 it was not possible to note each time whether an incoming adult carried food, but even when no food was seen by the observer, the adult would make feeding motions after it had come to the young. Therefore, it is assumed that each time an adult came to any nest, feeding took place.

At Nest 2, the eggs hatched between 7:01 p.m., May 15, and 12:30 p.m., May 16, when the nest contents were checked briefly. Between 2:30 and 5:15 p.m. the male made seven brief trips to the nest, on three of which he was definitely seen to carry food. Following two of these trips, when the female was at the nest, he left with his bill empty, but after the third, made in the absence of the female, he left with the food still in his bill. In the same period, the female came to the nest five times between brooding periods, but it was not possible to see whether she carried food on these trips. In Nest 3 the four eggs were intact at 6:38 a.m. on June 7. At 9:17 a.m. the male visited the nest for 30 seconds; when the nest was inspected at 10:19, three eggs had hatched. Between 10:19 and 11:58 a.m., he made no further trips to the nest; the female left and returned six

times in this period. On one return trip her bill was definitely empty, and on two trips she carried insect larvae. Between 3:22 and 5:50 p.m., the male came to the nest nine times. On five trips he carried insect larvae, and on two of these trips his bill was crammed with food. In this period the female came to the nest five times; on three trips no food was seen in her bill, but on two trips her bill was crammed with larvae. From these observations, it appears as though both adults feed the young on the day of hatching. Baumann (1959:196–198) found that the newly hatched young at one nest were fed almost entirely by the male, with only one definite feeding by the female in 7 hours and 40 minutes of observation.

Table 7

Rates of Feeding of Nestlings by Adults

Date	Female attendance (per cent)	Total trips by male	Total trips by female	Male's hourly rate	Female's hourly rate	Total hourly rate
			Nest 1			
July 1	51.1	15	16	2.5	2.67	5.17
2	48.9	27	29	3.0	3.22	6.22
3	46.4	27	24	3.4	3.00	6.40
4	30.0	38	31	4.2	3.44	7.64
5	30.8	9	10	4.5	5.00	9.50
6	24.0	40	43	5.0	5.37	10.37
7	11.0	34	47	4.9	6.71	11.61
8	3.8	26	43	4.9	8.11	13.01
			Nest 2			
May 17	80.6	53	14	3.7	0.98	4.68
18	88.6	39	7	3.5	0.61	4.11
19	68.0	49	11	3.4	0.76	4.16
20	70.4	33	8	2.8	0.95	3.75
21	63.1	48	14	3.4	0.98	4.38
22	54.9	51	26	3.4	1.74	5.14
24	21.1	57	51	4.0	3.58	7.58
25	11.6	37	53	3.3	4.75	8.05
26	0.0	7	18	2.0	5.27	7.27

The daily rates of feeding nestlings by the males and females at nests 1 and 2 are summarized in table 7. The amount of feeding done by the female was almost entirely dependent on the amount of brooding which she performed. At Nest 2, where brooding was very heavy during the first five days after hatching day, the female did relatively little feeding, and the male fed much more frequently. On the sixth day, the female's feeding rate began to rise, on the eighth day it nearly equaled the male's, and it definitely surpassed the male's on the ninth and tenth days. The male's feeding rate varied within narrow limits until the tenth day, when it fell off sharply, so that on that day the female made about two and one-half times as many trips as the male.

At Nest 1, at which the female's attendance was far lower, she made about the same number of trips as the male during the first six days after hatching day. During the seventh and eighth days her feeding rate rose sharply, and on the eighth day she made 62 per cent of all trips to the nest. As at Nest 2, the female's feeding rate rose more or less steadily as her attendance fell off. On the other hand, the male, unlike the male at Nest 2, showed a steady rise in feeding rate during the first six days and then remained constant during the seventh and eighth days.

Since Nest 1 contained four young, and Nest 2 only two, it may well be that the

decreased attendance at Nest 1, and the higher feeding rates at that nest resulted from greater demands on the adults by the larger number of young. At Nest 2, the combined feeding rates varied irregularly between fairly narrow limits during the first five days after hatching day, rose steadily and sharply on the sixth, eighth, and ninth days, and fell off sharply on the tenth day, reflecting the great decrease in the male's feeding rate on that day. In contrast, the combined feeding rate at Nest 1 rose steadily throughout the nestling period, and it was considerably higher throughout than the combined rate at Nest 2.

When the male came to Nest 2 in the absence of the female, he tended to stay for longer periods than when the female was present. This tendency was specially well-marked during the first five days after hatching day (table 8); after the sixth day the male's visits rarely coincided with the presence of the female, and aside from occasional brooding by her, neither adult stayed at the nest longer than was presumed necessary

Table 8

Mean Duration of Male's Visits to Nest 2 in Presence and Absence of Female[1]

Date	Female on	Female off
May 17	54.0 (28)	104.7 (15)
18	46.7 (30)	102.2 (5)
19	41.3 (32)	146.0 (12)
20	34.3 (20)	86.8 (8)
21	45.2 (20)	99.7 (15)
22	33.4 (11)	39.4 (29)

[1] In seconds; number in parentheses.

to feed the young. At Nest 1, with its far lower rate of attendance by the female, the visits of the male did not often coincide with the presence of the female and they tended to be brief whether the female was on the nest or not. However, the six longest visits to the nest by the male on the second, third, and fourth days after hatching day, ranging from 1.5 to 8.0 minutes, were all made in the absence of the female. On these visits the male, after feeding, stood on the nest rim and watched the young. Gray (MS) noted that at Nest 1 the "♂ stays a shorter time when ♀ is at nest."

At Nest 1, it was possible to see that if the male brought food when the female was present, she would either back up or move to one side to permit the male to feed the young directly; the food brought by the male was never transferred to the female for delivery to the young. Twice, while the male was feeding the nestlings, the female reached up and took insects from the side of his bill and fed them to the young, but these were the only instances in which the male did not deliver all of his food directly.

The average frequency of feeding by hour of the day is given for Nest 1 in table 9

Table 9

Average Number of Feeding Trips per Hour at Nest 1 from July 1 to 7

Hour	5–6 a.m.	6–7	9–10	10–11	2–3 p.m.	3–4	4–5
♂	4.5	3.5	3.5	4.0	3.5	4.0	3.3
♀	4.5	3.8	3.7	3.7	4.7	4.0	5.0
Both	9.0	7.3	7.2	7.7	8.2	8.0	8.3

and for Nest 2 in figure 2. At Nest 2 it may be seen that the male fed more frequently in the early morning than in the late afternoon. The female fed at a rather even rate from 5:00 to 11:00 a.m. She fed at a much reduced rate between 11:00 a.m. and 2:00 p.m., reflecting the lengthy periods of brooding in this period during the first six days

after hatching day. She then fed at a somewhat higher rate during the remainder of the afternoon, but less frequently than she had during the morning. At Nest 1, the greatest frequency of feeding occurred between 5:00 and 6:00 a.m. As opposed to Nest 2, feeding was generally more frequent in the afternoon at Nest 1. On the basis of the frequencies recorded at these two nests, there appears to be no well-marked daily trend, except that the highest rate of each nest occurred in either the first or second hour of the day.

When the frequency of feeding at Nest 2 is plotted hourly for all of the days of observation combined (fig. 2), it will be seen that the frequency for male and female combined and for the male alone accord rather closely, especially from 5:00 to 10:00

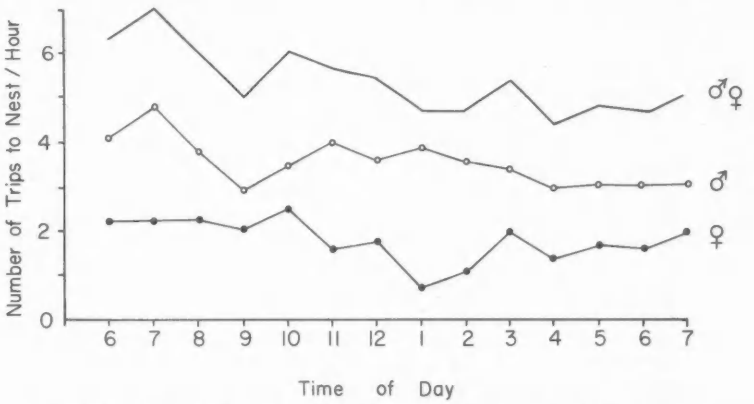

Fig. 2. Mean hourly feeding rates at Nest 2 for male and female together, male alone, and female alone, for all days of observation combined, May 17 to 25, 1954. Time of day on abscissa; number of trips to the nest per hour on ordinate.

a.m. In this period, the hourly frequency of feeding by the female varied very little. In other words, hourly variation in the frequency of feeding up to 10:00 a.m. was established by hourly variation in the male's feeding rate superimposed on the nearly constant feeding rate of the female. Between 10:00 a.m. and 2:00 p.m. both adults fed the young less frequently than during the early morning. The decline in the female's feeding rate is especially well-marked, reflecting the heavy brooding which she accomplished in this period on the first six days after hatching day. From 3:00 to 7:00 p.m. both adults fed less frequently than from 5:00 to 10:00 a.m. For the female this undoubtedly reflects the heavy brooding which she did between about 4:30 and 6:30 p.m. on the first three days of the nestling period.

There appeared to be a seasonal shift in the nature of the food brought to nests 1, 2, 3, and 4. At Nest 2, between May 16 and 26, the food brought to the nest on 143 trips was identified as insect larvae, and on five trips as imagos. The first imago, a moth, was brought on the sixth day after hatching day. At Nest 4, on May 16, 17, and 19, larvae were brought 14 times and only one imago, a moth, was noted. At Nest 3, on June 7 and 9, larvae were brought on 40 trips and imagos on none. In sharp contrast, food items specifically noted as brought on 20 trips to Nest 1 consisted of larvae on seven trips, grasshoppers on nine, and imagos on four. One of the imagos was a moth. On July 6, Gray (MS), noted that "food consists mainly of grasshoppers this p.m.," and in his summary of activities at Nest 1, he noted that "food consisted mainly of

grasshoppers, ranging in size from ¾±″ long to ¼±″ long. Other insects . . . and some larvae were also brought to the nest." From these data, it appears possible that nestlings in early nests are fed mainly larvae, whereas nestlings in later nests are fed mainly grasshoppers, the shift coinciding with the relatively greater abundance of larvae in the spring and the relatively greater abundance of grasshoppers in the early summer.

BEHAVIOR DURING NESTLING PERIOD

At Nest 2, as we have seen, the female's attendance from May 17 to 22 ranged from 54.9 to 88.6 per cent; from May 24 to 26 it ranged from 0.0 to 21.1 per cent, and during this latter period her rate of feeding the young rose sharply. The amount of time spent singing by the male from May 17 to 21 ranged from 13.3 to 21.5 per cent, and from May 22 to 25 from 34.8 to 50.1 per cent (Davis, 1958:322). Although the periods of high female attendance and decreased male singing do not coincide perfectly, the nestling period can be divided into two general parts, one from May 17 to 21 characterized by close attendance of the female and frequent and prolonged silences of the male, and one from May 22 to 26, characterized by the decreasing attendance of the female and the resumption of frequent singing by the male. Although the male was noticeably more silent during the first five days after hatching day than he had been during the incubation period, his trips to the nest with food, in combination with his occasional periods of calling or singing, served to break up effectively his long periods of silence and reveal his whereabouts to the sitting female. His activity immediately preceding 48 departures of the female from the nest was noted between May 17 and 21. Only three times did the female leave while the male was singing, a marked contrast to the situation that prevailed during the incubation period. Three times she left while the male called; twenty-five of her departures were preceded by the male's silence. In the remaining 17 instances she left the nest as the male came in with food, thus exchanging with him; she did not always wait for him to come close to the nest but several times flew when he was 10 to 20 feet away.

When coming to the nest, the male used a variety of approaches, sometimes using one or the other of the female's two takeoff points but more frequently flying down from some other point on the fence west of the nest. Often he approached at such a low level that I lost sight of him in the thicket west of the nest. Apparently when using the low approach he hopped through the grass between the fence and the nest; after following the early stages of his approach I would lose sight of him until he suddenly flew up from the nest after delivering food. In general his approach was less conspicuous than that of the female, who continued to use the same takeoff points that she had used during the incubation period. As then, she nearly always called briefly on her way to the nest, sometimes from her takeoff point, whereas the male usually came in silently. In general, the most striking feature of the first five days of the nestling period lay in the silent and stealthy behavior of the male.

By May 24, the male again sang at a rate comparable to that of the incubation period; the female's attendance had decreased sharply and her rate of feeding the young had increased to nearly equal that of her mate. At this time, and on through May 26, the last day of observation, the activities of the pair made them more conspicuous than at any time in the nesting period. In terms of concealing the whereabouts of the nest from possible enemies, these last three days were the most critical, as the frequency of visits to the nest was highest and the male, with his steadily increasing frequency of singing, was much more conspicuous than he had been. He frequently sang while foraging just prior to bringing food to the young, behavior that might easily attract a potential enemy's attention to him just before he flew to the nest.

During these last three days the parents used the same approaches to the nest that they had been using, with one exception. In the midafternoon of May 24, the female, who had been doing all of her foraging upslope from the nest, started to forage occasionally in the extreme north end of the thicket west of the nest. When leaving this area to bring food to the young, she worked her way through the thicket at such a low level that I could follow her only a short distance. Apparently, she went the whole way on the ground. After following the early stages of her approach, I would next see her as she flew up from the nest. On May 25 she did about half of her foraging in the thicket, but on May 26 she was again using the upslope foraging area and her usual approach to the nest. The temporary switch to the thicket may have been an attempt to find a new foraging area; perhaps this spot was abandoned because of the laborious approach to the nest through the length of the thicket.

At Nest 1, Gray noted the side of the nest to which the adults came in 475 of their trips with food for the young between July 1 and 8. There was a noticeable difference between the parents, the male coming to the west side of the nest 211 times and to the south side 28, the female coming to the south side 223 times and to the west side only 13.

At Nest 1, both sexes were faithful in disposing of the fecal sacs of the young. During the first few days of the nestling period the adults usually ate the sacs, but later they almost invariably carried them away. All nests that were found were remarkably clean and showed no evidence of fouling. The female at Nest 1 often worked on the bottom of the nest before settling to brood. Toward the end of Gray's observations the nest became badly stretched, at first because of the movements of the young, but in part because on July 7 a king snake (*Lampropeltis getulus*) crawled onto the nest before being removed by the observer.

NEST ENEMIES

Most enemies can be divided into three categories: predators on eggs and young, non-predatory animals that may accidentally damage the nest by trampling, and brood parasites. The most important predators, as judged by their abundance and by the reactions of nesting towhees to them, were the Scrub Jay, the king snake, and the California ground squirrel (*Citellus beecheyi*). The appearance of a jay near Nest 2 always evoked loud and steady calling by the male. If the female were not on the nest, she would join her mate, both birds calling loudly and rapidly as they moved about, keeping near the jay until it left the area. At Nest 1, Gray noted several times that the sitting female would peer alertly toward jays screaming nearby.

At Nest 3, on the morning of June 9, the female was absent when the male returned at 8:59 with food for the young. He perched in an oak near the nest and was about to fly down to the young when a jay landed on a fallen branch a few inches from the nest. The male at once flew downslope, calling loudly; the jay peered down, almost certainly at the nest, and seemed about to fly down to it, when the female flew in rapidly, uttering loud, squealing notes unlike any I had ever heard given by a Rufous-sided Towhee. She hovered in front of the jay, her wings beating and tail fanned, literally screening the nest from the intruder. At this point the male flew rapidly upslope toward the nest and the jay screamed once and flew. The female at once went down to the nest. It was obvious that the jay would have destroyed the nestlings had not the female intervened, and it was equally obvious that the male was completely ineffective in defending the nest and returned to it only after the female had appeared. Following this episode the male's singing rate rose appreciably and remained high for the rest of the morning (Davis, 1958:323). Despite this successful defense the young, which had hatched on June 7, had disappeared by the morning of June 11.

King snakes were noted endangering nests twice. At Nest 1, on July 7, Gray noted the two adults calling loudly near the nest for about two minutes, and then a king snake about four feet long came into view, crawling up to the nest from below. After the snake had reached the nest, both parents dived at it and struck it with their wings, but not with their bills. As Gray watched, the snake probed at the nestlings with its tongue; by the time the observer reached the nest, the snake was actually lying on top of the four young. The snake was removed and the nestlings, although appearing stunned and crushed, recovered, and appeared to have suffered no harm, although they would have been destroyed had not the snake been removed.

At Nest 2, on May 22, the male, in an oak near the nest, flew down to the thicket just west of the nest and called loudly several times; he then started toward the nest but suddenly flew down to the grass between it and the dirt road to the east and rushed at something, his wings outstretched and his tail fanned, as he called loudly and steadily. The female left the nest but remained near it, also calling loudly. The male made several rushes, his impetus carrying him several feet past the grass and out into the adjacent roadway. The female moved about calling loudly but remaining near the nest. I moved until I could see the object of their concern, a small king snake approximately 15 inches long and about 5 feet from the nest. I then returned to my original station. The male continued to make rushes at the snake, his neck bent, head down, wings outstretched, and tail fanned and nearly touching the ground. He attacked the snake for a total of eight minutes, and for the next four minutes the parents continued to call loudly. Forty-three minutes after the male's first attack I checked the nest and found both nestlings unharmed and the nest intact. In the meantime the male had started to forage and the female had returned to the nest, leaving a few minutes later to forage. Both adults made several trips with food, but they would go only as far as their takeoff points, refusing to go down to the nest and swallowing the food that they had brought. It was obvious that the birds had become so wary after their experience with the snake that they would not go down to the nest in my presence, and I left the area.

Ground squirrels were not established near Nest 2 but they frequently wandered near it. Any squirrel moving about near the nest invariably evoked loud calling by the male, or by both parents if the female were off the nest. As when Scrub Jays threatened, the female absolutely refused to go to the nest if a ground squirrel were nearby. Thus, in addition to the direct threat that predators present to eggs and young, they also present an indirect threat. The steadfast refusal of the female to return to the nest in the presence of a predator makes it seem possible that the mere presence of a predator near a nest on a very hot or cold day, or during a period when the nestlings might be in direct sun, could, if sufficiently prolonged, keep the female from eggs or young long enough to result in their death from exposure.

Other predators noted near nests were striped skunks (*Mephitis mephitis*), western gray squirrels (*Sciurus griseus*), and a longtail weasel (*Mustela frenata*). A wood rat (*Neotoma fuscipes*) with a house in the thicket adjacent to Nest 2 was ignored by the towhees although it was active several times in the daytime. Once the female at Nest 2 left the nest to pursue a large western whiptail (*Cnemidophorus tigris*) which had come near. The pursuit consisted of a slow herding of the lizard and the female returned to the nest after the whiptail had retreated about 15 feet.

None of the nests followed by Gray or myself went to completion. Nest 2 came the closest; the young, hatched on May 16, were still being fed on the morning of May 26. Their fledging period, according to the figures presented by Baumann (1959:199), was about over. Yet the parents suddenly broke off their steady feeding of the young and after some time had passed, I checked the nest and found it empty. If the young had

left the nest, some predator must have captured them almost immediately, as I never saw them again. The nests of Rufous-sided Towhees, built on or near the ground, are perhaps in so much danger at all times that any interference by an observer may tip the balance in favor of the predator. A few visits to the nest to mark eggs or examine young may flatten surrounding vegetation enough to form a path which will be investigated by a squirrel or snake, or even lead the eye of a jay perched above to the nest. At any rate, the ultimate failure of all the nests observed in this study may well have resulted from revealing the whereabouts of each nest to predators through the disturbance caused by observers.

Baumann (*op. cit.*:191) mentions only Scrub Jays and Brown-headed Cowbirds (*Molothrus ater*) as causing concern to nesting towhees, and the nests studied by him were apparently not destroyed by predators, despite his frequent visits to them, although he notes that each pair "lost, or abandoned" at least one nest (*op. cit.*:190). Perhaps the absence of terrestrial predators such as snakes and ground squirrels in his study area accounted for the higher nesting success of the pairs watched by him.

The second category of potential nest enemies, those which might accidentally damage nests by trampling, includes rabbits, deer, and quail. Nest 3 was almost trampled by a doe; she was standing 10 feet from it and suddenly became aware of my presence and bolted. Only the fallen branches adjacent to the nest kept her from running over it. Nest 2 was protected on the west by a dense thicket 35 inches away, but a dirt road and bordering strip of grass on the east provided no protection. However, the nest had been placed at the west base of a small California wild rose (*Rosa californica*) which had been browsed down, probably by deer, to a small, stout stub about six inches high. Twice, a pair of California Quail (*Lophortyx californicus*) dashed across the road and passed within two feet of the nest. The protective value of the small rose stub became apparent, as it would serve to turn aside running birds or small mammals which might have accidentally stepped on eggs or young.

Brood parasitism of Californian races of the Rufous-sided Towhee is rare. The worst offender appears to be the California Quail; a number of towhee nests have been found containing eggs of this species (Nidiologist, 2:85, 1895; Atkins, 1916:201–202; Bleitz, 1956:77–78; Cohen, 1899:63; Taylor, 1885:142). Parasitism by the Brown-headed Cowbird has been reported rarely for coastal races of the Rufous-sided Towhee in California. However, the continuing increase of cowbirds in the coastal regions of California may result in more frequent parasitism by this species. At the Hastings Reservation breeding of the Brown-headed Cowbird was recorded for the first time in the summer of 1959, with the Blue-gray Gnatcatcher (*Polioptila caerulea*) as the host species (R. B. Root, MS).

SUMMARY

Nesting of the Rufous-sided Towhee at the Hastings Reservation in coastal California occurs between about April 20 and June 20. Extreme dates for the discovery of nests containing eggs are April 10, 1960, and June 28, 1941. Most pairs apparently raise one brood.

Nests are built solely by the female. Most nests are placed on the ground, and the choice of nest materials and the placement and size of nests varies between very narrow limits.

Incubation is performed solely by the female. During the incubation period, which fell between 12.07 and 12.33 days for one nest, the male visits the nest and brings food to the incubating female. Attendance during incubation is not significantly correlated with temperature and does not change with stage in incubation.

Brooding is performed solely by the female. During the first half of the nestling period, when the female's brooding attendance is high, the male does most of the feeding of the young. As the female's attendance decreases, her rate of feeding the young rises steadily and near the end of the nestling period it surpasses that of the male.

The most serious nest predators of this species at the Hastings Reservation appear to be the king snake, Scrub Jay, and California ground squirrel.

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Hastings Reservation, University of California, Carmel Valley, California, June 5, 1960.

BIRDS OF LITTLE DIOMEDE ISLAND, ALASKA

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The Eskimo village of Ignalook on Little Diomede Island, Alaska, is isolated, and facilities for visitors are limited. Few ornithologists have visited the island. We are aware of no recorded observations on birds of the island in spring other than those given here. Summer observations, mostly of a general nature, were presented by Jaques (Auk, 46, 1929:230, and Nat. Hist. Mag., 1929:521–529) and Jenness (Can. Geog. Jour., 7, 1933:87–92). Brooks' observations of 1953 were available to Gabrielson and Lincoln during preparation of the "Birds of Alaska" (1959). Much of this material, however, was not utilized. Repetition in the present paper is avoided except in a few instances where comparisons of observations of 1953 and 1958 appear desirable.

Little Diomede is situated in Bering Strait 20 nautical miles west of Cape Prince of Wales and 2.25 miles east of Big Diomede (USSR). Fairway Rock lies 8 miles and King Island 52 miles southeast of Little Diomede. The island is 2 miles long, north to south, and 1.5 miles wide, east to west. It rises steeply to a nearly flat plateau at an altitude of 1308 feet. Vegetation is sparse and limited to patches and crevices among the tumbled granitic boulders and outcrops. Beaches, except for a few narrow stretches of large cobbles, are nonexistent; steep rocks and cliffs extend directly into the sea.

In the course of studies of marine mammals, Brooks spent the period from April 25 to June 26, 1953, and Kenyon from May 10 to June 14, 1958, on Little Diomede or on the sea in its vicinity. Both of us kept systematic records of birds, although Brooks did not attempt to list all species seen. Specimens of species presumed to be unusual at this locality were collected whenever possible in 1958.

The season of 1953 was characterized by a period of unusual warmth in early April but cool weather later caused an unusually late spring. However, leads were open near Little Diomede in April and May. In 1958 only a few narrow leads opened near the island until the latter half of May when considerable areas clear of ice appeared. This condition apparently affected the arrival dates of murres at the island; however, breeding activities commenced at about the same time as in 1953. As will be noted in the following annotated list and table 2, the arrival dates of a number of species were nearly the same in both seasons, as were also the periods of passage of certain migrants going from Alaska to Siberia. A total of 40 species is listed of which 13 are known to breed on Little Diomede.

Table 1

Estimated Magnitude of Populations of Birds Known to Breed at Little Diomede

Species	Minimum	Maximum
Phalacrocorax pelagicus	100	200
Larus hyperboreus	100	500
Rissa tridactyla pollicaris	20,000	100,000
Uria (*aalge* and *lomvia*)	50,000	200,000
Cepphus columba	200	500
Cyclorrhynchus psittacula	10,000	20,000
Aethia cristatella	100,000	500,000
Aethia pusilla	500,000	1,000,000
Fratercula corniculata	5,000	10,000
Lunda cirrhata	500	1,000
Calcarius lapponicus alascensis	50	100
Plectrophenax nivalis nivalis	200	500

Most of the small passerines observed and collected in 1958, although not previously recorded from Little Diomede, might be expected to land there en route from wintering grounds in the Old World to breeding areas in Alaska. Species wintering in North America may find the island a convenient resting place when blown from usual spring migration routes.

Few attempts were made to census populations. An attempt was made to estimate a lower and upper limit for the numbers of each species thought to be present. Large numbers are difficult to estimate, thus the order of magnitude of the populations could be expressed as an exponent of 10. However, when the estimated upper and lower limits are given we believe that a more concrete expression of the approximate order of magnitude of each population is achieved.

Table 2

Arrival Dates of Birds at Little Diomede

Species	1953	1958	Remarks
Chen hyperborea	May 22–24	May 20–June 1	Migration passed
Grus canadensis	May 15–22	May 17–20	Migration passed
Rissa tridactyla pollicaris	May 15	May 14	First sighted
	May 21	May 20	First on cliffs
Uria (*aalge* and *lomvia*)	April 27	May 16	First seen
	May 3	May 20	First on cliffs
	June 11	June 9	First breeding behavior
Cyclorrhynchus psittacula	May 29	May 26	First on rocks
Aethia cristatella	May 22	May 20	First seen
Aethia pusilla	May 18	May 23	First seen
	ca. May 25	May 27	First on rocks
Fratercula corniculata	June 2	June 2	First seen
Lunda cirrhata	June 2	May 26	First seen
Nyctea scandiaca	May 23	May 26	First seen

SPECIES LIST

Fulmarus glacialis rodgersii. Fulmar. Ira N. Gabrielson (*in litt.*) saw only two at Little Diomede, both white phase, near Fairway Rock on July 26, 1946. In 1953 Brooks was told by the Eskimos that the Fulmar, locally called "walrus bird" is not known to nest on Little Diomede. In 1958 Kenyon saw none near the cliffs. All those seen at Little Diomede in 1958 were of the white phase. The first was seen on May 29, flying over narrow leads among ice floes about 1 mile east of Little Diomede. Other individuals were seen on June 3, 5, and 9. On June 10, 20 Fulmars circled and fed in the channel in front of Ignalook Village. On June 13 the birds were numerous and constantly in view over the water from the village.

Phalacrocorax pelagicus pelagicus. Pelagic Cormorant. Brooks found cormorants present on April 25, 1953, and he believes he observed two species, one larger than the other. In 1958 only *pelagicus* was noted but no special search for *Phalacrocorax urile* was made. One cormorant was seen near the north end of the island from the aircraft before landing on May 11, 1958. The natives said that cormorants are present throughout the winter, when they feed in leads, particularly around the north point of the island. Large numbers were not seen on the cliffs until May 18. The greatest concentrations were at the north and south ends of the island. While we hunted walruses from umiaks, groups of cormorants were often seen resting on broken pressure ridges of ice floes. Croaking mating calls were heard from the cliffs frequently on May 20.

Olor columbianus. Whistling Swan. On May 20, 1958, two flew past Little Diomede and disappeared in the direction of Siberia. They flew low over leads, passing among ice floes. The bills appeared completely black.

Branta nigricans. Black Brant. On June 3, 1958, a flock of ten was seen flying westward toward Big Diomede. On June 9 a subadult was seen sitting on the hillside north of the village.

Chen hyperborea. Snow Goose. In 1953 the first flocks appeared on May 22 and by the evening of May 24 the migration had ended. On May 20, 1958, a flock of four in company with three Sandhill Cranes, flying in line, headed directly west over the ice south of the village. On May 23 a flock of six was closely observed resting on an ice floe as it drifted with the current past the south point of the island. On May 29 and 30 several flocks flew westward, and on June 1 they were heard calling while moving over the village in a westerly direction.

Anas acuta. Pintail. On May 18, 1958, an adult male circled over the village. On May 23 one pair was seen on a lead near shore at the south end of the island. On June 9 an adult male flew north along the shore near the village and a male in subadult plumage was shot on the hillside behind the village. Gonads were enlarged (25 × 7 mm.).

Anas crecca. Green-winged Teal. On June 10, 1958, an adult female (*nimia* or *carolinensis*?) was seen resting on an ice floe near the village. It was driven away by dogs and no others were subsequently seen.

Polysticta stelleri. Steller Eider. Small flocks were seen between May 25 and June 5, 1953. None was seen in 1958. Apparently the northward migrants usually stay close to continental coast lines.

Clangula hyemalis. Oldsquaw. In 1953 these ducks appeared to pass in greatest abundance near Cape Prince of Wales. On May 14, 1958, the first pair was seen in a lead at the south point of the island. Pairs and small flocks, headed north or east, were seen on the open water during the entire period.

Histrionicus histrionicus. Harlequin Duck. The first were seen on June 2, 1958, a flock of approximately ten, flying northward over open leads near the south end of the island. On June 5 two pairs were seen near shore ice north of the village.

Somateria mollissima. Common Eider. This species is often taken for food by the Eskimos. On May 16, 1958, approximately 100 were seen on open leads south of Little Diomede. Although we saw a number of flocks while on walrus hunting trips at sea, we also spent several entire days on the water in late May without seeing this species.

Somateria spectabilis. King Eider. Between May 14 and June 2, 1958, flocks of from 4 to 35 were seen on several occasions flying low over the water among ice floes. Dead individuals were seen at several Eskimo homes on May 11 and the Eskimos said that they often take them on leads in the winter and early spring. Brooks has observed that while great numbers migrate northward near Cape Prince of Wales in May relatively few are seen near the Diomede Islands.

Lampronetta fischeri. Spectacled Eider. This species did not appear numerous at Little Diomede in 1958. One adult male was brought in by a hunter on May 11 and several hunters said that they had seen a few after this date.

Grus canadensis. Sandhill Crane. In 1953 the migration passed between May 15 and 22. Flocks en route from Alaska to Siberia frequently passed both north and south of Little Diomede in mid-May, 1958. During periods of low visibility, the birds could often be heard but not seen. On May 17 four flocks were seen; on May 18 a flock of 27 and another of 24 were closely observed and a number of others were reported by Eskimos. On May 20 a flock of 62 and 3 other individuals, accompanied by 4 Snow Geese, passed by. A number of hours was spent in the field subsequent to May 20. On May 23 a particular effort was made to record the passing of cranes but none was seen during nine hours of field observations and none was reported by hunters. Apparently the entire migration passed in four days, from May 17 to 20.

Erolia alpina pacifica. Dunlin. Only stray migrants were seen. On May 20, 1958, a lone bird flew north along the edge of the ice pack and alighted on floating ice about 2 miles east of Little Diomede. Another was seen on the ice near shore rocks at the south end of the island on May 30. A male in breeding condition was taken on June 1 (USNM no. 465837) as it looked for food among rocks and snow patches at the water's edge.

Phalaropus fulicarius. Red Phalarope. A few migrants stopped at Little Diomede in late May and June. On May 29, 1958, an adult in breeding plumage, probably a female, searched for food in a pool of melt water on shore ice. On June 6, two flew among the ice floes about 8 miles south of Little Diomede. Between June 10 and 14, 10 to 15 birds searched energetically for food under and near the shore ice shelf along the west shore of Little Diomede. A male in breeding condition was taken on June 10 (USNM no. 465841).

Stercorarius pomarinus. Pomarine Jaeger. On May 20, 1958, a flock of eight, in dark plumage, was headed north in direct flight close to the water 1 mile east of Little Diomede. On May 29 five were seen and on June 10 one was seen. On June 14 and 15 several were seen at Wales where they appeared more numerous than at Little Diomede.

Larus hyperboreus. Glaucous Gull. On June 7, 1953, the Eskimos brought in about two dozen Glaucous Gull eggs, some of which were in late stages of incubation. Although some gulls nest on Little Diomede, the Eskimos say that the Fairway Rock colony is larger. Gulls were relatively scarce at Little Diomede until about May 15, 1958. On June 10 Eskimos from Diomede visited Fairway Rock and found full sets of eggs which had been laid only a few days previously.

Rissa tridactyla pollicaris. Black-legged Kittiwake. Incubation was in progress on July 26, 1946, when Ira N. Gabrielson visited the island (*in litt.*). In 1953, the first kittiwakes were seen at Little Diomede on May 15, the first landed on the cliffs on May 21, and egg laying had not begun on June 25.

On May 11, 1958, several flocks of 20 to 100 were seen in open leads among the ice during a flight between Nome and Little Diomede. On May 14 four were seen flying over the ice south of Little Diomede. As leads opened near the island, the birds became numerous. Twenty were seen on May 16 and on May 18 huge flocks of many thousands were present on open leads near the island. On May 20 at 8:00 a.m. thousands rested on cliff ledges, many of them on the snow. By 7:00 p.m. thousands more had come to the cliffs. Previous to May 20 not one bird had been seen on the cliffs. By 1:00 a.m. on May 21 the cliffs were again completely deserted by kittiwakes. Until May 26 no birds were seen visiting the cliffs and relatively small numbers were seen near the island over open water. On May 26 several hundred birds rested on ice and open water near shore but only about 100 to 200 were on the cliffs. The cliff population gradually increased until by May 29 every available ledge and old nest was occupied by pairs of kittiwakes. The first subadult bird was seen on June 5 and numbers had increased considerably by June 14.

The behavior of kittiwakes, in making a preliminary visit to nesting cliffs in great numbers and then deserting them completely for five days before returning to stay, is of interest because of its similarity to behavior patterns of other larids. For example, the Sooty Tern (*Sterna fuscata*) approaches the colony site at first by night, then in daylight for several days before finally resting on the ground intermittently at night. The periodic approach of the flock to the colony site is described for the Herring Gull, *Larus argentatus* (Tinbergen, The Herring Gull's World, 1953:44–45).

Uria aalge and *Uria lomvia*. Common Murre and Thick-billed Murre. On April 27, 1953, large flocks (50 to 200) began passing Little Diomede heading north, and their migration continued until about May 5. During the same period, several thousand birds accumulated in the open leads near Little Diomede and began landing on the cliffs at the south end of the island on May 3. Breeding was observed on June 11, and the first eggs were found on June 19.

So many of these birds were seen that it was not ascertained which species was more numerous. Large flocks were seen on open water on May 11, 1958, during the flight from Nome to Little Diomede. Their number decreased sharply on the narrow leads 2 or 3 miles south of the island. None was seen near Little Diomede until May 16 when leads opened near the island, at which time flocks of several hundred were present, and by May 20 many thousands were present on the water. In the morning none rested on the cliffs, although by 7:00 p.m. many thousands were there, most of them sitting on snow and ice. Several birds were seen fighting and in one case two birds locked in combat fell to the surface of the shore ice where they continued to fight, their beating wings leaving a trail for several yards in the snow. By midnight the majority of birds had left the cliffs and by 3:00 a.m. on the morning of May 21 not one remained. Between this date and May 31 a few birds occupied the cliffs intermittently but at 1:00 p.m. on May 31 none was seen there. They again began to occupy ledges by midafternoon. From this time on the cliff population steadily increased and birds were present there at all hours. Breeding behavior was observed on June 9.

Cepphus columba. Pigeon Guillemot. In 1953 small numbers were seen on April 25, but no eggs had been found by June 25. On May 14, 1958, two were seen in a narrow lead south of Little Diomede; in the course of a day at sea on May 20 approximately 20 individuals, some in pairs, were seen. Erratic courtship flight was observed near an open lead on May 21. The number of pairs occupying open water south of the island increased. On May 26 six pairs were seen near shore. By May 31 sev-

eral pairs were seen flying close to island cliffs and on June 2 several pairs occupied holes in cliffs at the south end of the island. By June 13, when open water was available all around Little Diomede, the number of Pigeon Guillemots had increased to a hundred or more pairs.

Cyclorrhynchus psittacula. Parakeet Auklet. In 1953 this species was first seen to settle on Little Diomede on May 29. The first flocks of five to ten individuals were seen on May 20, 1958, well offshore on open water among ice floes. By 7:00 p.m., 500 to 600 birds were seen near shore. By May 23

Fig. 1. Habitat areas at the top of Little Diomede Island on June 2, 1958. Two Wheatears fed among rocks at the edge of the tundra patch in the foreground. Longspurs had taken territories on the rock-strewn plateau at left, and auklets (*Aethia* and *Cyclorrhynchus*) occupied the rock slides on the right. Photograph by Kenyon, June, 1958.

thousands flocked on open water near shore. On May 26 auklets were flying high above the island and a few individuals landed on the highest rocky outcrops. By May 31 large numbers began to assemble high on the rocky slopes at about 4:30 p.m. Between this date and June 4 the numbers increased rapidly. The Parakeet Auklet appears to be the least numerous of the three species of small alcids. During late May, the most auklets were in the air from late afternoon until the early morning hours in spite of the fact that daylight prevailed during 24 hours. On foggy days the auklet flights began later than on sunny days.

Aethia cristatella. Crested Auklet. On May 20, 1958, three were seen flying over open leads 3 miles east of Little Diomede. By May 25 flocks of from 5 to 30 birds flew high above the upper slopes of the island in early afternoon; by late afternoon the flocks approached the rocks closely and a few landed on the higher slopes. An assemblage of many thousands gathered on an open lead south of the island, then took to the air, broke into smaller flocks and circled up about the island. The citrus-like odor of this auklet is often quite noticeable, both on the water and in nesting areas. On May 29 the odor of a flock of about 10,000 auklets was quite strong at least half a mile downwind while the birds were hidden from view by fog. Large flocks on the water increased daily until by June 3 a number of flocks consisted of an estimated 5000 to 10,000 birds. As soon as a large flock took to the air, it broke into small groups of four to ten birds and circled upward around the island. The greatest number of birds was in the air and on the rocks at about 2:00 a.m.

Aethia pusilla. Least Auklet. The first was seen on May 23, 1958, and by May 26 a few flew about the upper slopes. At 3:00 a.m. on May 27 thousands flew over the village and landed among the rocks. By June 10 Least Auklets were by far the most numerous birds about Little Diomede. The heaviest flights occurred from 9:00 p.m. to about midnight. By June 8 it appeared that the majority of available nesting areas had been taken and flocks of 500 to 600 Least Auklets, accompanied by a few of the other two species, rested on snow drifts that still covered portions of the rocky hillside. These birds appeared to be awaiting access to nesting areas. On June 10 at twelve noon not one bird could be seen flying. By 2:00 p.m. a few were flying and the number rapidly increased during the afternoon and evening hours.

Fratercula corniculata. Horned Puffin. The puffins are the last summer residents to reach Little Diomede. The first puffins arrived on June 2, 1953, and egg laying had not commenced by June 25. The first puffin was also seen flying over open water on June 2 in 1958. On June 3 two were seen on cliffs at the south end of the island and two others flying along the cliffs. On June 6 several pairs flew over open water and along the cliffs. On June 10 many hundreds occupied cliff ledges. This species outnumbered the Tufted Puffin to a considerable degree.

Lunda cirrhata. Tufted Puffin. On May 26, 1958, one bird made numerous close passes along the rocky cliffs at the south point of the island. Numbers increased slowly until June 13 when scattered pairs occupied cliffside ledges.

Nyctea scandiaca. Snowy Owl. In 1953, one was seen on May 23 and the Eskimos said that this owl is more numerous in fall than spring. One adult was seen on the top of the island on May 26, 1958.

Asio flammeus. Short-eared Owl. Two were seen flying westward past Little Diomede on May 20 and 22, 1953. The species was not observed in 1958.

Corvus corax. Raven. On April 25, 1953, three flew from Big Diomede to Little Diomede. Subsequently they were seen almost daily. On May 14, 1958, one was seen flying about near open leads south of Little Diomede and on June 1 a lone bird flew from Big Diomede toward the north end of Little Diomede. The Eskimos said that two or three Ravens always wintered at the Diomedes and that sometimes they nested on the higher outcroppings of Little Diomede. It is doubtful that any nested there in 1958. The species is apparently present in small numbers throughout the year.

Oenanthe oenanthe oenanthe. Wheatear. On June 2, 1958, a pair of birds was flushed from among large boulders near the edge of the flat top of Little Diomede. They were quite wary but a female was taken (USNM no. 465838). Although this species is recorded as breeding at Wales and a specimen was taken on Little Diomede by Dufresne in 1924 (Gabrielson and Lincoln, The Birds of Alaska, 1959:668), it is not known to breed there.

Phylloscopus borealis kennicotti. Arctic Warbler. Only one individual was seen, on June 12, 1958. It hopped about energetically among large granite boulders as it searched for food among lichens and patches of dead grass near the schoolhouse. The bird, an adult female, was taken (USNM no. 465842). Although this species is not previously recorded from Little Diomede, its presence there is not surprising. It winters in tropical Asia, has been recorded from other Bering Sea islands, and breeds in western Alaska.

Motacilla alba. White Wagtail. Single birds were seen on June 4, 10, and 13, 1958. They were very elusive and shy. Each bird passed rather rapidly along the island shore and did not return to an area after leaving it. An unsuccessful effort was made to collect each individual. Identifying characteristics were observed through binoculars. Nesting of this species on St. Lawrence Island is recorded (Fay and Cade, Univ. Calif. Publ. Zool., 63, 1959:129).

Motacilla flava tschutschensis. Yellow Wagtail. On June 13, 1958, an adult female was observed for half an hour (12:30 p.m. to 1:00 p.m.) before it was obtained (USNM no. 465844). It repeatedly flew to an altitude of about 75 feet over a selected spot, then while descending on rapidly vibrating wings uttered a high-pitched trill. One other was observed later the same afternoon as it flew rapidly along the steep Diomede hillside. The breeding range of this species includes western Alaska areas but it has not been recorded previously from Little Diomede.

Anthus cervinus. Red-throated Pipit. On June 12 and 13, 1958, several pipits were observed as they flew low over the rocks and grassy patches on the steep lower slopes of Little Diomede. The birds were quite wary and exact identification of the five or six pipits seen was not certain. However, two adult males in breeding condition were collected (USNM nos. 465843 and 465845), one on June 13

and one on June 14. This species has not previously been recorded from Little Diomede but there is one nesting record from Wales (Bailey, Condor, 34, 1932:47). A more careful exploration of Little Diomede may show that it breeds there also. The species is represented by only three other specimens from North America.

Acanthis hornemanni. Hoary Redpoll. One bird was seen on May 18 and another on June 13, 1958. Both were quite light colored and were thus considered to be this species. They flitted among rocks along a steep hillside and were so persistently chased by Snow Buntings that neither could be obtained. Although not previously recorded from Little Diomede, redpolls probably visit there in small numbers on migration as they do at other Bering Sea islands.

Junco hyemalis hyemalis. Slate-colored Junco. On June 5, 1958, one bird, a male in breeding condition, was obtained (USNM no. 465840) on the rocky hillside behind the village. The bird was chased by a White-crowned Sparrow but repeatedly returned to one area where it was taken. Two Eskimos said they had never seen a bird like it there before. The species has been found on other islands of the Bering Sea but not previously on Little Diomede.

Zonotrichia leucophrys gambelii. White-crowned Sparrow. On June 5, 1958, a male in breeding condition was first heard singing from the hillside behind the village where it remained for about 12 hours before being taken (USNM no. 465839). The Eskimos said that usually they saw one or two of these birds in the spring, but they had never found its nest on Little Diomede. This is a common species on the mainland of Alaska and is probably blown occasionally from its usual migration route to islands in the Bering Sea. It is not previously recorded from Little Diomede.

Calcarius lapponicus. Lapland Longspur. In 1953 only a single pair was observed. On May 27, 1958, an adult male was seen on a grassy stretch among rocks above the village. On May 29 several males in soaring song flight were frequently visible in this area. On June 2 about ten pairs were seen on the flat top of Little Diomede. A nest with five fresh eggs was found on June 9 about 300 yards north of the schoolhouse. On June 13 this nest contained six eggs and a second nest with seven partly incubated eggs was found nearby.

Plectrophenax nivalis nivalis. Snow Bunting. In 1953 the birds arrived in the first part of April. Eggs were found on June 1. Birds of this species were numerous along the lower slopes of Little Diomede on May 11, 1958. Courtship behavior was apparent on May 14. On May 18 numerous males sang and disputed territorial boundaries among rocky outcrops. Between the hours of 11:00 p.m. and 2:00 a.m. no singing was noted. Singing began about 3:00 a.m. and continued throughout the day. On May 23 four females and one male were seen to arrive at the island from the south. On May 24 females were first seen gathering nesting material and by May 31 numerous mated pairs occupied territories along the shore and hillside. Only one nest, with a female incubating, was found on June 10. One male (USNM no. 465836) was taken on May 31, 1958.

United States Fish and Wildlife Service, Seattle, Washington, and Alaska Department of Fish and Game, Juneau, Alaska, February 1, 1960.

HOSTILE DANCING AND FALL TERRITORY OF A COLOR-BANDED MOCKINGBIRD

By JACK P. HAILMAN

The curious "dancing" behavior of the Mockingbird (*Mimus polyglottos*) has been known to ornithologists for many years. Careful field studies of color-banded birds by Laskey (1933, 1935, 1936) and Michener and Michener (1935) provide evidence that dancing is a means of establishing territorial boundaries, although others (for example, Forbush, 1929:320–321; Sprunt, *in* Bent, 1948:298–299; Lovin, Chat, 23, 1959:31) have described it as a form of courtship. I decided to re-evaluate dancing by measuring territory as accurately as possible, studying the relation of dancing to it, and analyzing in terms of ethological description the form and biological function of this performance. This paper is a summary of the results of a part-time field study conducted in November and December of 1958.

I am grateful for the comments of Mrs. Amelia S. Laskey and Mrs. Josephine R. Michener on this study and on the manuscript.

TERRITORY OF RED-YELLOW

Description.—I caught a Mockingbird with a mist net on November 16, banded it with a red and yellow band for field identification, and studied the bird on its territory until late December when it disappeared. I believe that the bird was either a female or a juvenile because of its rather mild aggressiveness as compared to other Mockingbirds in the vicinity. The small size and the shape of the white wing patches also indicate that the bird may have been in its first winter (see Michener, 1953:76, fig. 1). By using obvious perches, flying across the open lawn, and calling from the tops of trees, Red-yellow indicated that it had already established a fall-winter territory. The territory of Red-yellow is an example of the class of winter territory of Nice (1943:57). The general area included a typical suburban residence of Norfolk, Virginia, with much open lawn and scattered bushes and trees (fig. 1). The territory was measured by several independent criteria which will be discussed later; all measurements conveniently coincide (figs. 1, 2).

One measure of "territory" is demonstrated by figure 1, which charts the principal perches and flight paths utilized by Red-yellow during the autumn. There was no noticeable change in the frequency of use of any of the perches in the course of the study period. Often a circuit of the territory began in the pin oak tree in front of the house and led from there to the bushes at the head of the driveways, back down the strip between the driveways, across the yard to the trellis, along a line parallel to the lake shore to the trees behind the house, and back over the house to the pin oak in front, thus describing a loose figure eight.

The areas in which Red-yellow foraged or fed are another criterion of "territory," as indicated also in figure 1. The bird fed most often on berries of bushes planted along the strip between the driveways, and it also fed in the area near the trellis. In the early fall it fed on the lawn near the street, presumably on insects, but as the season progressed Red-yellow did not return to this area; this was the only "territorial change" observed throughout the season, hence the dotted line in figure 2. The limits of the territory measured by other means correspond well to an imaginary line drawn to include feeding areas.

Two other, more accurate, measures of territory are (a) the limits of area within which no other Mockingbirds occurred and (b) the limits within which Red-yellow acted aggressively. These are shown in figure 2 by a heavy black line and by squares

containing an "X," respectively. The aggressive acts indicated by the squares are the perches from which the aggression note *chuck* (Laskey, 1933, 1935) or a quick *chip* (Michener and Michener, 1935; Michener, 1951) was commonly uttered. The only place Red-yellow was actually seen to chase another Mockingbird was near the head of the

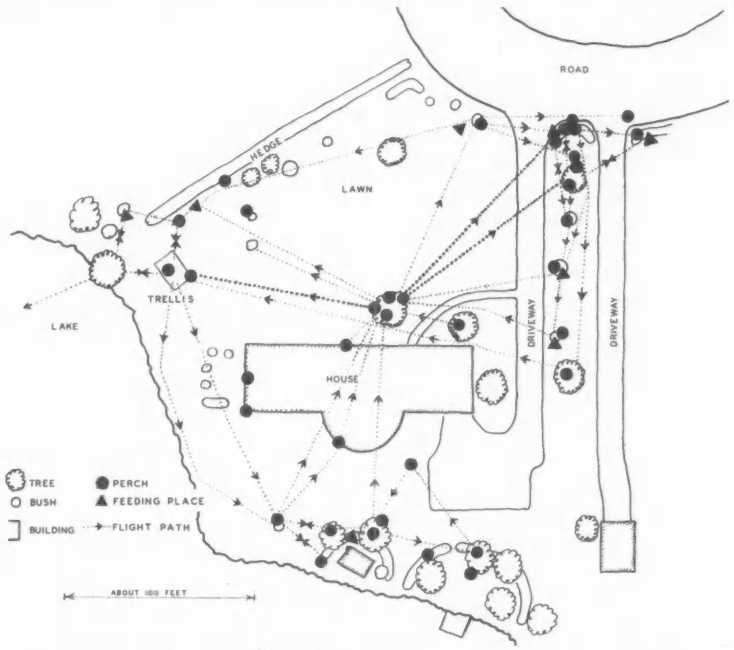

Fig. 1. Territory of Red-yellow as indicated by its perches (circles), flight paths (dotted lines), and feeding places (triangles). Compare with figure 2.

driveways, which provides a fifth territorial indicator. This probably demonstrates a relatively low level of aggressiveness in Red-yellow, because other Mockingbirds in the vicinity often engaged in aerial chases.

It should be emphasized here that the heavy line in figure 2, which is called the territorial boundary, enclosed: (1) the area in which Red-yellow was found, (2) the area in which it fed, (3) the area in which it gave the aggression call, (4) the area in which it chased another Mockingbird, and (5) the area in which no Mockingbirds other than Red-yellow were seen.

Function of winter territory.—It has already been pointed out that the territory of Red-yellow included certain feeding areas, and the bird usually spent more time perched near these areas than it did in other parts of its territory. It is also noteworthy that Red-yellow did most of its dancing in the vicinity of the berry bushes between the driveways (fig. 2). These observations agree well with those of Michener and Michener (1935:134), who conclude that "the winter territory centers about the food supply and is defended by both the male and the female, in case the pair remain together, or by the

lone male or female occupant." Laskey (1936:243) also notes that "food is an important item of consideration" in the winter territory of the Mockingbird.

Another function of winter territory which has been frequently suggested by ornithologists is that of protection from predators (see Nice, 1943:57). By living in a restricted area, an individual presumably is able to learn certain hiding places which can

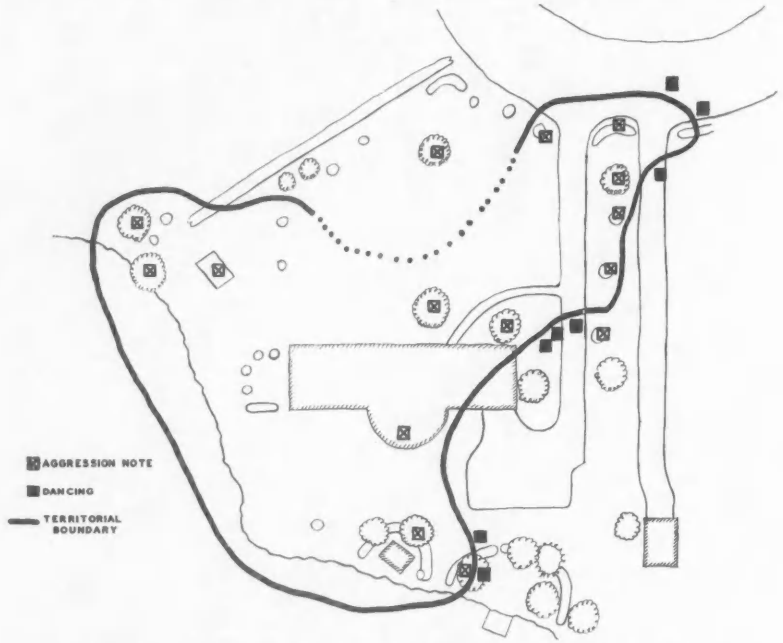

Fig. 2. Relation of aggressive *chuck* notes (crosses in open squares) and dancing bouts (solid squares) to territorial boundaries (solid line). See text and figure 1.

help it escape detection or attack. In the case of Red-yellow, this does not seem to have been important. The only avian predator seen in the area was a Sparrow Hawk (*Falco sparverius*) which normally does not prey on Mockingbirds and no attacks were observed. Bent (1948) mentions few enemies of the Mockingbird. The Sparrow Hawk in Norfolk was not seen after November and it is unlikely that any other predators which could prey on Mockingbirds would have escaped notice for very long. The disappearance of Red-yellow on December 16 could have been due to death by a predator. However, the disappearance coincided with a snowstorm which may have killed the bird or driven it away. Red-yellow had several cysts or parasites of some sort on its face (Hailman, 1959) which may also have contributed to its death.

Male Mockingbirds often remain on winter territory and expand it into breeding territory (Laskey, 1933; Michener and Michener, 1935); whether successful establishment of a breeding territory is contingent upon possession of a winter territory is not known. Therefore, it appears that Red-yellow defended a fall territory principally to insure its food supply rather than for protection from predators, or for other reasons.

DANCING

Relation of dancing to territory.—The observations of dancing ceremonies involving Red-yellow and unbanded Mockingbirds are shown in figure 2 by black squares. It is evident that the dancing of Red-yellow always took place along a territorial border, as defined previously. Because Red-yellow sang only two or three times after October and showed no other signs of reproductive behavior whatsoever, it seems highly plausible that the fall dancing was strictly concerned with territorial defense.

Description of hostile dancing.—Although dancing motions have been described several times (Forbush, 1929:320–321; Laskey, 1936:250; Michener and Michener, 1935:126; Sprunt, *in* Bent, 1948:296), the exact posture of the bird apparently has not been noted in detail. Since feather postures and movements are very important in communicative behavior (Morris, 1956), it is important that adequate descriptions of the form of these motions and postures be recorded.

All except one of the dances of Red-yellow occurred on the ground. In a dance, two Mockers stand face to face on the ground, with legs parallel, wings drawn in to the sides, and tail erect. The appearance of each is generally "tall-and-thin," the effect being aided by compression of body feathers and very upright stance. In the ground displays, the wings are not opened, and the tail is only occasionally spread slightly; it is never fully fanned. What follows is best defined as a series of movements, each of which occurs more or less at right angles to the previous movement, with a decided tendency for one individual to move whenever the other moves and for the two birds to keep close together. Thus, if one bird jumps forward, the other may jump forward or to the side to meet the first face-to-face, in which case the first Mocker may retreat with a hop to the side or to the rear. If the second does not hop to meet the first, then a new line is established. This process, I believe, continues until a boundary line is established beyond which one bird will not retreat and the other will not advance, and so each hops mainly to the side. Further evidence of the hostile nature of dancing is the fact that Mockingbirds' dancing bouts often begin or end with actual fighting (personal observation; and Laskey, 1933, 1936:250).

On November 16, I saw a complete dancing ceremony occur in one of the trees behind the house. It took place on the outer limbs of the tree, about 15 feet above the ground. On December 7 I saw the conclusion of another dance in the same tree. This second, incomplete observation is not included in figure 2. The general situation appeared to be the same as for dancing on the ground, with one individual hopping in advance and the other hopping to meet it. In addition, when one bird hopped down to another limb, the other followed, and the same occurred when one hopped up, so that the vertical dimension of movement is as important as the other two in arboreal dancing.

The feather postures, as well as the motions, were modified somewhat in arboreal dancing. Although each bird took an upright stance, with body feathers compressed, wings drawn to the sides, and tail erected, some motion of the wings and tail, plus associated spreading of feathers, took place. I suspect these are primarily balancing and flight intention motions which do not have any communicative significance. However, one component may be more than simply an unritualized locomotor element superimposed on the dancing display. Twice in the course of the arboreal dancing the opponent noticeably cocked its tail to the side, in full view of Red-yellow, and fanned the feathers so that the white tail feathers "flashed." It appeared as if this were a deliberate display of the fanned tail, but because the motion was seen only twice, nothing definitive can be stated about it. I have been unable to find any previous report of arboreal dancing in the literature, although Laskey (1936:35) noted opponents which met in a tree but departed without hostility.

Relation of dancing to courtship.—It had been my original intention to study dancing throughout the year in order to determine its relation to courtship. However, the departure of Red-yellow prevented this, and no other individuals could be marked. A few careful accounts of dancing during the reproductive season (Laskey, 1933, 1935; Michener and Michener, 1935) show that dancing was used only in territorial defense between males. These same studies show that pairing displays are accompanied by vocal activity. Pairing behavior may also include song flights, wing-fluttering and other displays. It is possible that hostile dancing attracts females to the displaying males, but accounts like Laskey's (1933) make the possibility seem unlikely. It is also possible that wing-fluttering, or another courtship action, might be superimposed on dancing, but this has never been reported. In fact, neither Mrs. Michener (personal communication) nor Mrs. Laskey (personal communication) has seen dancing used in any way between mates or potential mates during the reproductive season.

SUMMARY

The winter territory of a color-banded Mockingbird (*Mimus polyglottos*) was mapped on the basis of where the bird lived, fed, and behaved aggressively (figs. 1, 2). Territoriality seemed to be primarily a means of insuring a food supply. Dancing usually occurred on the ground, although it was twice seen in the branches of a tree. In dancing, birds face each other with bodies and tails erect, and they advance or retreat in short hops, until a boundary line is established that neither can cross without being challenged by the other. Dancing is therefore considered to be a hostile display used in territorial defense. Dancing probably has no relation to courtship.

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4401 Gladwyne Drive, Bethesda, Maryland, February 25, 1960.

NUTRITIONAL CONDITION OF WATER PIPITS ON ARCTIC NESTING GROUNDS

By LAURENCE IRVING

It is important to determine how late in the breeding cycle migratory birds preserve the fatness that they acquire just before departure from their wintering grounds. I have presented records showing that male birds of a number of species were fat when they reached their arctic nesting places at Anaktuvuk Pass, Alaska (Irving, U.S. Nat. Mus. Bull. 217, 1960). The evidence also indicated that after arrival the males lost fat. The records that I presented did not show the rapidity of the change in fatness, and I have now compiled a clearer series of records of the condition of arctic Water Pipits (*Anthus spinoletta*) from the dates of their arrival from migration until their eggs were laid.

The data are prepared from examinations of 45 pipits at Anaktuvuk Pass (lat. 68°21′ N; long. 151°50′ W) in the central part of the Brooks Range, Alaska, and 13 pipits at Old Crow, Yukon Territory (lat. 67° 24′ N; long. 139° 50′ W) at the junction of the Old Crow and Porcupine rivers. Fifty of the examples were prepared as specimens which I identified as *Anthus spinoletta rubescens*. The linear distance from their nearest known wintering place in Texas is about 3000 miles (A.O.U. Check-list, 1957).

The average date of arrival of pipits at Anaktuvuk Pass has been May 10 for six recent years. At this early date the mean temperature is below freezing and drops much lower at times in the next two weeks (U.S. Weather Bureau). In some years the snow may have already blown from exposed parts of the tundra, but there is little melting and the rivers do not break up for two or three weeks. At Old Crow the phenomena of spring were only a few days earlier than at Anaktuvuk, and in 1957 ice began to run in the Porcupine River on May 22.

Anaktuvuk is the nesting place of many pipits. For ten days after their first arrival in swift-flying flocks, many flights pass daily. At the peak of migration in 1949, on May 19, Thomas Brower estimated for me that he identified 500 pipits. By the end of the week following the peak of migration, the number of flocks usually diminishes to only a few a day. Among the early flocks some are already scattering as if to nest nearby. Since most pipits nest inland from the arctic coast, the northernmost nesting area is only a hundred miles north of Anaktuvuk, which is therefore practically at the terminus of migration. The arctic coast is only 130 miles distant from Old Crow, and there, pipits were also practically at the terminus of their migration. In 1947, only a few small flocks alighted in the meadow near the village on May 6, 7, and 8 and the last were seen there on May 14. The nearest nesting pipits were found on Old Crow Mountain five miles distant.

At Anaktuvuk (fig. 1) and Old Crow (fig. 2) the earliest male pipits were on the average heavy and the majority were fat. A decline in weight and fatness occurred at Anaktuvuk between May 15 and 21, and for the next month their weight and fatness did not change. Pipits were not collected on Old Crow Mountain until June 9, when three males were found to be light and lean.

A male pipit collected from a flock on the Alaskan Highway at Takhini River about sixty miles west of Whitehorse on May 3, 1958, was very fat. Its longest testis measured 2 mm. The testes of the other male pipits were less than maximum size upon arrival at Anaktuvuk and Old Crow and only attained full size a week later at Anaktuvuk on May 14. The males at Anaktuvuk were then fat.

During the next week, and until the latest measurement on June 13, the testes remained unchanged in size. Attainment of maximum size of testes signaled the decline

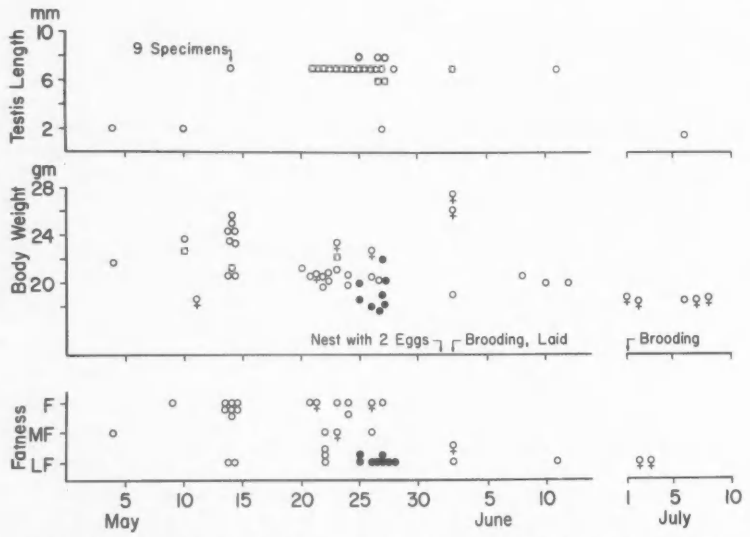

Fig. 1. Greatest length of testes, weight and fatness of Water Pipits (*Anthus spinoletta*) at Anaktuvuk Pass, Alaska. Open circle, males 1949, 1951; ♀, females 1949, 1951; solid circle, males 1954.

of the fatness of male pipits. Behavior associated with great testicular influence is a reasonable cause for the loss of weight and fat. The males were then singing and their song in flight is a strenuous performance. But singing is only a signal for the cares of the breeding male. On their breeding grounds, pipits change from sociable birds in flocks to strongly antisocial defenders of a territory and mate. Since the first eggs were found on June 1 and all six females examined thereafter had laid, the social reorganization and progress of mating occurred in a period of about 20 days after the first arrival of the males.

It can be suggested from observations during the breeding season that male pipits are so occupied with domestic affairs that they do not spend much time feeding. At any rate the fat, some 10 per cent of their weight, that they had transported during migration was utilized during mating. Not only male birds, but males of large herbivores and fur seals utilize their stores of fat and become lean in rutting season.

Early records of female pipits are too few to show their condition at the end of migration, but during the time that males are growing lean, females gain until they are sometimes 30 per cent overweight even without large eggs. The production of eggs is a remarkably efficient transformation but laying an egg daily adds some 20 per cent to the hen's intake of calories (Brodie, Bioenergetics and Growth, 1945:882). Female pipits lay five or six rather large eggs in the arctic, probably at the rate of one a day. In addition they are concerned with the preliminary labor of building a nest. While incubating they can satisfy their food requirements only in the periods when they leave the nest. At that time there can be no want of food on the arctic nesting grounds if the nesting cycle is to proceed.

The fatness of male pipits arriving in the arctic shows that in their recent migratory experience they have not suffered nutritional stress. The schedule of their annual

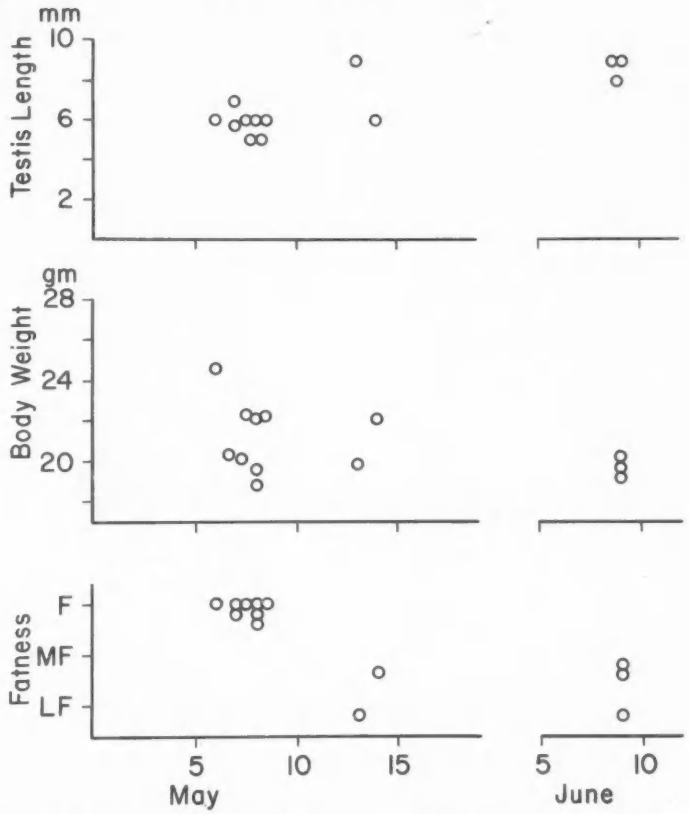

Fig. 2. Greatest length of testes, weight and fatness of male Water Pipits at Old Crow, Yukon Territory, Alaska, 1947.

arrivals and the distance covered does not allow for irregular wandering in search of food during migration. Birds must find food abundant even in the early and cold periods before and after they reach their arctic nesting places. Although the males utilize their fat, the amount lost is not more than three grams which would provide 27 kilo-calories of energy in metabolism. This is about the quantity of metabolic energy that Jon Steen (Ecology, 39, 1958:625–629) found expended in three days by a 22-gram European Tree Sparrow (*Passer montanus*) in Norway. It is evident that enough food is obtainable by arctic birds without long interruption of their intense concern for breeding. Although the males grow lean on the nesting grounds, they are not poor and are actually in good plumage and full of vigor after a long migration to a land where, to all but its residents, existence seems possible only with suffering and under stress.

ACKNOWLEDGMENTS

I am indebted to Simon Paneak of Anaktuvuk Pass for records obtained in 1954 and to him and Thomas Brower for help with earlier records. Leonard J. Peyton and F. S. L.

Williamson assisted in obtaining the records at Old Crow. Jo Kay, a former chief of the village of Old Crow, knew when and where to look for the arrival of pipits and obtained our first specimens.

SUMMARY

On arrival at arctic nesting grounds at Anaktuvuk Pass, Alaska, and Old Crow, Yukon Territory, male Water Pipits identified from 50 specimens as *Anthus spinoletta rubescens* were three grams heavier and fatter than just before nesting. At the time of arrival on May 10, testes were less than half maximum length; maximum size was attained by May 14. Thereafter the size of testes did not change during June, but by May 21 weights had declined and most males were lean. The first egg was laid on June 1. While the males lost weight during mating, females held or gained weight until after laying.

Arctic Health Research Center, Anchorage, Alaska, March 10, 1960.

FOOD HABITS OF THE CALIFORNIA QUAIL IN EASTERN WASHINGTON

By CHARLES G. CRISPENS, JR., IRVEN O. BUSS, and CHARLES F. YOCOM

The Columbia Basin, which lies east of the Cascade Mountains in the state of Washington, is a semiarid region rimmed on all sides by plateaus, hills, and mountains. A tilted plateau, which is the center of this study of food habits, extends eastward from the Columbia Basin, crosses southeast Washington, and reaches to the forested foothills of the Moscow Mountains in western Idaho. This plateau is topographically characterized by undulating loessel soils over basalt; its vegetation consists of three principal associations. An *Agropyron-Poa* association occurs on a large central part of the plateau, a *Festuca-Symphoricarpos* association on its higher eastern edge, and an *Artemisia-Poa* association on its lower western edge.

The California Quail (*Lophortyx californica*) was established by introduction in eastern Washington over forty years ago, and today it is one of the important game birds in this region. According to the records of the Washington Department of Game, 108 birds were released in Walla Walla County in 1914. The following year, 12 quail were released in Garfield County and 48 in Yakima County. In 1920, 19 birds were released near Spokane. Subsequent releases of imported stock are believed to have given rise to the main concentrations before the Department of Game established its program of trapping and transplanting these birds from areas of high populations to other suitable ranges in the state.

By 1920, when 80 per cent of Adams, Spokane, and Whitman counties was in farmland, the Sharp-tailed Grouse (*Pedioecetes phasianellus*) was nearing extirpation in southeast Washington as a result of agricultural practices associated with wheat farming (Buss and Dziedzic, 1955). The consolidation of farms and the introduction of diesel-powered tractors in the 1930's encouraged removal of fencerows and resulted in destruction of much cover for wildlife (Dziedzic and Ball, 1950). Since 1940 brush removal, weed control, and stream grading have continued and limited drastically the cover available for upland game birds. In canyons and other restricted areas where shrubby cover still persists, the California Quail attains relatively dense but widely fluctuating populations from which birds were obtained for this study. The edges of wheat fields near such covers provide an abundance of weed seeds and waste grain. The utilization of these foods by many of the quail involved in this study indicates the importance of weed communities, induced and maintained by a highly mechanized agriculture, to the California Quail.

MATERIALS AND METHODS

This study was begun in October, 1940, and continued until June, 1956. In that period, 89 gizzards and 291 crops were obtained from 310 California Quail collected in 12 of the 20 counties in eastern Washington. Although some of these quail were less than a year old, they were indistinguishable in size from adults. Consequently, this is a study of food habits of full-grown California Quail.

The procedure used in the analyses of crop and gizzard contents was similar to that described by Korschgen (1948). Identification of the plant seeds was facilitated by a reference seed collection.

All data were grouped into three-month periods as follows: Spring—March, April, May; at this time young plants become available, and birds are establishing territories and nesting. Summer—June, July, August; plants start to mature and seeds become

Table 1

Analysis of Crop Contents from 291 California Quail

Food items	Spring Percentage total volume	Summer Percentage total volume	Fall Percentage total volume	Winter Percentage total volume
Secale sp.	....	....	....	2.52
Verbena bracteata	Trace	....	2.21	Trace
Bromus tectorum	Trace	....	0.54	1.54
Avena fatua	0.26	....	0.49	0.88
Setaria sp.	....	....	Trace	1.29
Trifolium sp.	Trace	0.83	Trace	0.39
Vicia sp.	....	....	1.06	Trace
Rhus glabra	....	....	Trace	1.01
Crataegus douglasii	....	....	0.79	0.19
Solanum nigrum	....	....	....	0.87
Polygonum aviculare	....	....	0.11	0.70
Pyrus malus	....	....	0.78	Trace
Bromus sp.	....	0.55	0.16	Trace
Avena sp.	....	....	Trace	0.70
Calamovilfa longifolia	....	0.55	Trace	....
Erigeron sp.	0.53	....	....	....
Animal foods				
Orthoptera	....	0.55	1.78	Trace
Hymenoptera	0.30	1.66	Trace	....
Coleoptera	0.34	0.55	0.26	Trace
Unknown	Trace	0.55	0.15	Trace
Chaff	1.67	0.27	6.95	4.92
Grit	0.30	0.55	0.54	0.27
Miscellaneous				
Fruit pulp and skin	....	....	0.66	Trace
Total crops	31	9	164	87

available, birds generally have broods. Fall—September, October, November; waste grain and weed seeds are available in large quantities, broods are maturing and birds flocking. Winter—December, January, February; in this season waste grain and weed seeds are partly utilized, and some foods are covered with snow part of the time; the birds are in flocks.

RESULTS

Seeds represented the major portion of the diet of the California Quail, the most important being wheat (*Triticum aestivum*) which ranked first in percentage of total volume throughout the year. Other seeds which comprised more than 5.0 per cent of the total volume of material, but were seasonal in their consumption, included: Spring—*Chenopodium* sp., *Eleocharis macrostachya*; Summer—*Amaranthus graecizans, Amsinckia* sp., *Pisum sativum*; Fall—*Helianthus annuus, Salsola kali*; and Winter—*Dipsacus sylvestris, Melilotus alba, Polygonum aviculare, Robinia pseudo-acacia, Sisymbrium altissimum.*

Green plant material represented a significant percentage of food consumed by the quail. Although found in all seasons, this food item was utilized principally during the spring months.

Animal foods, primarily insects, appeared to be a minor component of the quail's

Table 2

Analysis of Gizzard Contents from 89 California Quail

Food items	Spring Percentage total volume	Summer Percentage total volume	Fall Percentage total volume	Winter Percentage total volume
Amsinckia intermedia	—	1.22	....	....
Symphoricarpos sp.	....	....	0.21	0.99
Chenopodium sp.	....	0.61	0.55	—
Bromus sp.	0.62	....	Trace	0.49
Melilotus sp.	....	....	0.55	0.49
Amaranthus retroflexus	....	....	Trace	0.99
Setaria sp.	....	....	Trace	0.99
Chenopodium botrys	....	....	....	0.99
Cirsium arvense	....	....	0.88	....
Lactuca scariola	....	0.61	0.21	....
Echinochloa crusgalli	....	....	0.77	....
Robinia sp.	....	0.61	0.11	....
Polygonum sp.	....	....	0.71	....
Sambucus sp.	....	....	0.66	....
Capsella bursa-pastoris	....	0.61	....	....
Cerastium sp.	....	0.61	....	....
Claytonia parviflora	....	0.61	....	....
Viola sp.	....	0.61	....	....
Amaranthus sp.	....	....	0.60	....
Lotus americanus	....	....	0.60	....
Vicia villosa	....	....	0.60	....
Unknown	....	2.44	1.74	....
Animal foods				
Hymenoptera	.. .	0.61	Trace	....
Grit	27.78	56.70	24.77	53.21
Chaff	62.35	18.90	30.60	1.48
Total gizzards	3	9	64	13

diet. These were utilized throughout the year, but they were eaten most frequently during the summer and fall.

Grit and chaff made up more than 50 per cent of the total volume of material found in gizzards but never exceeded 8.0 per cent in crops.

In all, 169 different food items were recorded of which 159 were plant species. Those items found in crops and gizzards in quantities greater than 0.1 per cent of the total volume are listed in table 1 and table 2, respectively. Those found in quantities of less than 0.1 per cent are as follows:

Animal foods: Arachnida, Diplopoda, Gastropoda, Hemiptera, Homoptera, Lepidoptera, Orthoptera and unknown animal material.

Plant foods: *Agropyron spicatum, Agropyron triticeum, Agrostis* sp., *Alisma plantago-aquatica, Amaranthus* sp., *Amaranthus hybridus, Ambrosia artemsiifolia, Amsinckia intermedia, Amsinckia lycopsoides, Anthemis cotula, Anthriscus sylvestris, Arctium minus, Asperugo procumbens, Astragalus* sp., *Atriplex* sp., *Avena sativa, Bassia hyssopifolia, Beckmannia syzigachne, Berberis nervosa, Berberis repens, Betula fontinalis, Bromus brizaeformis, Caucalis microcarpa, Ceanothus sanguineous, Celtis douglasii, Centaurea melitensis, Cephalanthus occidentalis, Chenopodium album, Chenopodium botrys, Chenapodium leptophyllum, Cirsium arvense, Cirsium vulgare, Claytonia* sp., *Claytonia linearis, Claytonia parviflora, Cleome serrulata, Convolvulus arvensis, Corispermum hyssopifolium, Crataegus doug'asii, Cuscata epithymum, Datura stramonium, Echinochloa crusgalli, Elymus* sp., *Epilobium* sp.,

Epilobium paniculatum, Erodium sp., *Erodium botrys, Erodium circutarium, Erysimum* sp., *Festuca* sp., *Glyceria borealis, Heracleum maximum, Hordeum* sp., *Iva xanthifolia, Lepidium perfoliatum, Lithophragma* sp., *Lithophragma bulbifera, Lomatium* sp., *Lotus* sp., *Lotus americanus, Lupinus* sp., *Lupinus sericeus, Madia glomerata, Medicago* sp., *Medicago lupulina, Melilotus* sp., *Nepeta cataria, Oenothera* sp., *Oryzopsis hymenoides, Panicum* sp., *Panicum capillare, Phacelia* sp., *Phacelia leucophylla, Philadelphus lewisii, Phleum pratense, Physalis* sp., *Physocarpus* sp., *Pinus ponderosa, Plagiobothrys hispidulus, Plantago lanceolata, Polygonum bistortoides, Polygonum convolvulus, Polygonum lapathifolium, Prunus* sp., *Pseudotsuga* sp., *Pseudotsuga menziesii, Ranunculus* sp., *Ribes* sp., *Rosa* sp., *Rubus laciniatus, Rumex acetosa, Rumex crispus, Rumex fenestratus, Rumex mexicanus, Sambucus glauca, Sanguinsorba* sp., *Setaria glauca, Setaria italica, Silene noctiflora, Silybum marianum, Sisymbrium* sp., *Solanum* sp., *Solanum dulcamara, Solanum nigrum, Sorgum vulgare, Stellaria* sp., *Suaeda* sp., *Taraxacum officinale, Thlaspi arvense, Trifolium agrarium, Urtica gracilis, Verbena bracteata, Verbena stricta, Vicia americana, Zea mays* and unknown plants.

Miscellaneous: feathers, lead shot, nut shell, wire.

DISCUSSION

Although the food habits of the California Quail have been studied in various parts of its native breeding range, this paper represents the first investigation of a similar nature on this species in eastern Washington where it was introduced.

Sumner (1935) found 103 species of plants and 16 species of animals in 102 crops taken from quail collected in California. Later, Glading, Biswell, and Smith (1940) examined 114 crops obtained over a period of one year in that state. The latter reported that seeds made up the major portion of the food items and were particularly abundant in crops from April to December. Insects occurred in low numbers and were found most frequently in April, May, and November. Green plant material comprised approximately 25 per cent of the total food items and was principally taken from February to May. The average grit content in 80 gizzards was 17.5 per cent.

Our findings agree essentially with those just discussed. It can be seen that the adult California Quail is primarily a vegetarian, with insects comprising less than 3.0 per cent of its annual diet. The observation that wheat accounts for 20 to 35 per cent of its total diet in eastern Washington is not surprising since wheat farming is the dominant agriculture in much of this area.

It has been suggested by Sumner (*op. cit.*) and Glading, *et al.*, (*op. cit.*) that the California Quail is selective in its feeding. Since the percentage of wheat which occurred in crops in the fall, when the most waste grain was available, was only 19.09 as compared to at least 24.36 during other seasons (table 1), it is evident that selective feeding also occurred in the quail of eastern Washington. Similarly, it appears that pigweed (*Chenopodium* sp.), teasel (*Dipsacus sylvestris*), and locust (*Robinia pseudo-acacia*) were utilized selectively. Evidently sunflower (*Helianthus annuus*), and Russian thistle (*Salsola kali*) were highly preferred since they were eaten almost exclusively during fall when most foods were available in greatest abundance. However, it appears that the utilization of prickly lettuce (*Lactuca scariola*) was governed primarily by availability. Finally, it was noted that as many as 20 different species of plants were frequently found in one crop, indicating the importance of availability.

ACKNOWLEDGMENTS

The authors are indebted to the more than 35 individuals who assisted in the collection and analyses of data.

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Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine; Department of Zoology, Washington State University, Pullman, Washington; Division of Natural Resources, Wildlife Building, Humboldt State College, Arcata, California, April 1, 1960.

Least Bittern (*Ixobrychus exilis*) in defensive posture at nest. Photograph taken by Robert K. Selander on June 9, 1959, at the Sabine National Wildlife Refuge, Cameron Parish, Louisiana.

FROM FIELD AND STUDY

Determinate Laying by House Sparrows.—In Larchmont, Baltimore County, Maryland, in 1960, an experiment was conducted on removal of eggs from a nest of the House Sparrow (*Passer domesticus*). As eggs were laid, they were taken, leaving always a single nest-egg. This procedure failed to cause continuous laying. Addition of eggs in a second nest on the first laying day failed to inhibit laying. The first bird laid clutches of 5 and 4 separated by a four-day interval in April and May and then deserted; the second bird laid either 4 or 5 eggs in May. In Baltimore City, in earlier years, House Sparrows using my boxes laid two clutches of 5 in April, and one in May and one in June, each of 4 eggs. My experiments, therefore, resulted only in normal, determinate laying. In a review of this subject, Davis (Condor, 1955, 57:82–83) found suggestions in the literature of indeterminate laying by this species when eggs were removed, but he said addition of eggs had never been tried. Barrows (The English Sparrow in North America, 1889:161) gives reports of indeterminate laying when eggs were removed. My experiments suggest that the "indeterminate" laying thus reported may really have been determinate laying of two or more clutches with intervals between.

The following are the details of events at the nest boxes. In the removal test the male was a color-banded bird and was identified during both laying periods. The female was unmarked. The first egg was laid on April 27. Beginning on April 28 I removed one egg each day, always leaving the latest laid. An egg was laid daily through May 1. I could not watch this box until May 1; at 10:10 a.m., E.S.T., there was copulation, then the female incubated steadily. Brief watching on May 2 and 3 showed almost no incubation being done. I could not watch on May 4 or 5. I do not know whether the female ever spent the night in this box. Laying was resumed May 6, and beginning that day I removed one egg daily as before. An egg was laid each day through May 9. The female did a little incubating on May 7 and 8, and she did much on May 9. But from May 10 on I never again saw the female at the box except on May 11 when copulation was noted and the female attacked a Starling (*Sturnus vulgaris*) there. The male also was seldom in evidence, although he defended the box occasionally through May 13. However, on May 13 a Starling broke the final egg; I replaced it, but the box was abandoned. The last egg of each clutch here was much lighter in color than the others, as is commonly true in the House Sparrow.

At the box where eggs were added, the adults were unmarked. The first egg was laid on May 13; I found it at 7:41 a.m., marked it, and immediately added 4 of the marked eggs I had taken from my other box. At 8:05 a.m. the male looked into the box and the female entered, so both birds learned of the 5 eggs with great promptness. On the next three days my wife inspected the box and found the following: 6 eggs on May 14 at 7:27 p.m.; 6 on May 15 at 10:57 a.m., and 4 on May 16 at 10:12 a.m. On May 17 at 9 a.m. I found there were 5 eggs—this female's first one, one of those I had added, and three unmarked ones. On this evening the female for the first time roosted in the box. At two House Sparrow nests which I observed in earlier years, the females began sleeping in the box only when, or after, their clutches were complete. Presumably three of my week-old eggs were thrown out of this test nest, and either one of this female's own eggs also was thrown out or else she skipped a day in her laying. However, she laid either 4 or 5 eggs, one of which was a light-colored one and this one was the last to hatch.—Hervey Brackbill, *Baltimore, Maryland, June 29, 1960.*

Quail Nesting inside Woodrat Houses in Baja California.—In the summer of 1957 ectoparasites were collected from the houses of woodrats (*Neotoma lepida*) at localities scattered the length of Baja California. On two occasions in the Cape region, south of La Paz, quail nests were found in the internal cavities of the woodrat houses. The first such association was discovered 5 miles north of Todos Santos on July 14, 1957, at an elevation of 800 feet. When this house was opened, a bird ran rapidly from the brushpile-like structure and into the surrounding vegetation. Six eggs were present in the nest; these eggs were collected and subsequently identified by Mr. W. C. Hanna of Colton, California, as those of the California Quail (*Lophortyx californicus achrusterus*). No woodrat was seen in this nest but the nest did have all appearances of having been recently active. The kissing-bugs, *Triatoma rubida rubida* and *Triatoma peninsularis*, were present in this nest; these bugs are obligate ectoparasites and rats of the genus *Neotoma* are their usual hosts.

A second similar association was found 9 miles northeast of Santiago on July 17, 1957. The quail

eggs in this nest had hatched but no birds were seen. There was no rat in this nest; it apparently had been eaten by a rattlesnake which was present in the nest at the time of inspection. This nest also contained *Triatoma rubida rubida* and *Triatoma peninsularis*.

The authors are reporting this biological association in the hope that it may be of some future value to ornithologists studying the ecology of quail. Funds for this expedition were made available from The Associates in Tropical Biogeography of the University of California at Berkeley and the College of Medical Evangelists of Loma Linda.—RAYMOND E. RYCKMAN and JOSEPH V. RYCKMAN, *Department of Microbiology, College of Medical Evangelists, Loma Linda, California, May 26, 1960.*

Baikal Teal in British Columbia.—On December 20, 1957, an immature male Baikal Teal (*Anas formosa*) was taken by the writer at Ladner, British Columbia. Contrasted with the specimen of a drake shot in May in central Siberia, the specimen has no white on the elongated scapulars but these are margined on the outer vane with rusty red and on the inner vane with pale tan-khaki. The patterns on the head are the same, except that on the specimen from Ladner the feathers of the four light patches are margined with gray. The black stripes on the side of the posterior neck, and, to a lesser extent, the mid-face stripes, have light tan-whitish feather margins; the black feathers of the front and crown are margined with a rusty color.

A Baikal Teal has been recorded from California (A.O.U. Check-list, 5th ed., 1957:76), but doubt exists as to whether the bird was wild or an escaped captive. The record of a wild bird in British Columbia tends to weaken somewhat the supposition that the California specimen was a captive.

The specimen from British Columbia is now the property of the Department of Zoology, University of British Columbia.—J. HATTER, *Fish and Game Branch, Department of Recreation and Conservation, Vancouver, British Columbia, February 1, 1960.*

Records of the Bar-tailed Godwit and Tufted Duck on Midway Atoll.—Through the courtesy of the United States Navy and financial aid provided by the American Philosophical Society, and the Bureau of Aeronautics, United States Navy, the author spent 14 days on Midway Atoll in the Pacific Ocean in December of 1959. The primary purpose of the trip was to obtain avian specimens for morphological and parasitological studies. However, a few study skins were prepared, and among these are two worthy of recording.

One female Bar-tailed Godwit, *Limosa lapponica baueri*, was taken on Sand Island on December 12, 1959. Although this species is known to migrate over water southward from the Aleutian Islands, there seems to be no specimen from Midway; the nearest locality of record, supported by a skin, is Laysan Island.

On December 5, 1959, a very emaciated, male Tufted Duck, *Aythya fuligula*, landed in a shallow puddle on a macadam road on Sand Island of the Midway group. The nearest known occurrence to the north is Wilson's sight record (Condor, 50, 1948:126) on Attu Island, some 1900 miles away. The nearest known occurrence to the west is in the Marianas Islands.

Both skins are in the collection of Southern Illinois University.

I am grateful to Dr. A. L. Rand of the Chicago Natural History Museum for identifying these two specimens, representatives of which I had never seen.

On each of my trips to Midway (1945, 1946, and 1959) there have been repeated reports of "owls and cormorants," made by naval personnel. In March, 1959, Mr. John W. Atwell (U.S. Navy) sent me a colored slide of two owls, taken as the birds left the perch. They were not identifiable except as owls. In December, 1959, a jaeger (*Stercorarius*) was observed repeatedly, but it could not be obtained. It would seem worthwhile for persons visiting the atoll to make an attempt to take specimens.—HARVEY I. FISHER, *Southern Illinois University, Carbondale, Illinois, May 16, 1960.*

An Instance of Piracy by the Red-tailed Hawk on the Peregrine Falcon.—On December 17, 1959, I went out just at dawn to feed my flock of pigeons. As I walked past the building in which they are kept the entire flock flushed at high speed from the roof where they had been perched. As they passed overhead, there was a sharp, hissing rush followed by a snapping crack, as though a dry stick had been broken. I looked up to see an adult male Peregrine Falcon (*Falco peregrinus*)

pulling out of a stoop and one of the pigeons flying in a little circle about eighteen inches across and almost hovering. The falcon curved back, but the pigeon managed to elude it, yet continued to fly in a very small circle. On the next pass the falcon, slowing almost to stalling speed, reached out its feet and grabbed the pigeon from the air, flying with it across a wide flat toward a timbered ridge about a quarter of a mile away.

I hurried toward the house to get the binoculars but had not gone inside when the flock of pigeons again flew past full speed toward the loft, hotly pursued by another mature Peregrine Falcon, this time a large female. The pigeons made the shelter of the loft and this falcon, too, flew across the flats toward the timber on the ridge.

Upon checking with binoculars, the falcon with the pigeon was found sitting on the side limb of a tall dead cedar snag. The pigeon, gripped by the neck, hung down below the limb, apparently dead. The larger falcon flew about the perched bird, made a couple of half-hearted passes at it, and then flew along the ridge a little way and perched in another tree.

Suddenly into the field of the binoculars came a Red-tailed Hawk (*Buteo jamaicensis*), wing-tips back, travelling at very high speed. The falcon with the pigeon screamed and took off, still carrying the pigeon, and dropped steeply down the ridge toward the flats in the opposite direction to the incoming hawk. The Red-tail did a beautiful twisting turn with scarcely any loss of speed and curved down and under the flying falcon. What happened then is none too clear; my impression was that the hawk turned upside down as it went under the falcon. In any event the pigeon was hurled from the feet of the falcon for a distance of some thirty feet and was immediately followed down by the Red-tail, which at once began to deplume the pigeon. It was set upon by both falcons which spent some five minutes screaming and diving at it, but it paid them scant attention and retained the pigeon.

This piracy may be more pronounced in the Puget Sound region than elsewhere. Wintering buteonid hawks in this area must feed primarily on birds, as there is no sizeable rodent population of any kind here.—FRANK L. BEEBE, *Provincial Museum, Victoria, B.C., Canada, April 21, 1960.*

Additional Distribution Records of Some Birds in Interior Alaska.—A number of observations on the distribution of birds in interior Alaska have come to my attention in the past few years and are recorded herewith.

Aythya americana. Redhead. On May 27, 1960, I saw a full-plumaged male Redhead at Smith Lake, near College. This locality is about 200 miles northwest of the Tetlin area where Hansen reported a breeding population in the summer of 1959 (Condor, 62, 1960:136–137).

Aythya collaris. Ring-necked Duck. Since the first specimen of the Ring-necked Duck in interior Alaska was taken on August 7, 1953 (Kessel, Condor, 57, 1955:372), several additional sight records have been made in the College area. Several of us watched a male at Smith Lake on May 19, 1957; Robert W. Kelly photographed a pair at Smith Lake on May 18, 1958; Earl L. Schene reported another pair from Goldstream Valley about 5 miles west of Ester on May 18, 1958; and a pair and a single male frequented Smith Lake between May 21 and May 27, 1960. Heinrich K. Springer watched a single bird, apparently an immature male, swimming in a small, ice-surrounded pool on October 9, 1960, about 3 miles east of Fairbanks.

Charadrius vociferus. Killdeer. These plovers appear to be only stragglers in Alaska; Gabrielson and Lincoln (Birds of Alaska, 1959) cite only four localities north of the Alaska Peninsula where they have been seen: Kuskokwin River, Mountain Village on the lower Yukon River, Tolugak Lake in the Brooks Range, and Point Barrow. Adding to these localities, I saw two of these birds on the fields of Creamer's Dairy Farm, between College and Fairbanks, on May 12, 1953; none has been seen in the vicinity in succeeding years.

Aphriza virgata. Surfbird. Until now the only definitely known breeding localities for the surfbird have been in McKinley National Park (Dixon, Condor, 29, 1927:3–16) and in the Forty-mile River area of eastern Alaska (lat. 64° 15′ N, long. 143° W; Murie, Auk, 41, 1924:231–237). On June 25, 1952, however, I came upon an adult male Surfbird with a downy chick at the top of a small, dome-shaped rise on Eagle Summit (lat. 65° 30′ N, long. 145° 30′ W) near the Steese Highway. The top of the dome is about 4000 feet in elevation and is largely bare, supporting a sparse, alpine *Dryas*-fellfield association. As I reached the top of the dome, the adult flew toward me and gave a broken-wing distraction display. I prostrated myself and after watching for about five minutes

saw the chick move at the far edge of the dome, the area from which the adult bird had originally approached me and away from which it had moved during its distraction display. The chick, which proved to be a female, weighed only 15.9 grams and was probably only a day or two old; as it tired in my hand, it relaxed and assumed a curled, pre-hatching position. Only one adult and one chick were seen on the dome, and after a period of observation they were both collected. They are catalogued as UA 766 (chick) and UA 765 in the University of Alaska Museum. The adult male weighed 133.2 grams and the right testis measured 3.5 × 5 mm.

Another breeding record was obtained at about 4000 feet elevation on Mastodon Dome, several miles south of Eagle Summit, on June 11, 1953. Here, in a habitat similar to that just described, Ronald O. Skoog flushed a Surfbird from four eggs.

Since recorded observations of this species away from the coast are few, two other records are worth citing: While climbing at over 3000 feet on Mt. Drum at the northwest end of the Wrangell Mountains, George B. Schaller saw five Surfbirds on May 23, 1954. Wilbur L. Libby, while in a small saddle at the top of Victoria Mountain (lat. 65° 48′ N, long. 146° 56′ W) in the White Mountains, saw five of these birds on July 2, 1955, and a pair on July 5, 1955. These latter observations, coupled with the breeding records from Eagle Summit and the Forty-mile River area, suggest that Surfbirds nest in suitable habitats throughout the Tanana Hills, from the Alaskan-Yukon border to the White Mountains.

Limosa haemastica. Hudsonian Godwit. This relatively rare godwit, according to Gabrielson and Lincoln (*ibid.*), has not been recorded in Alaska since 1907, and they state that "it is not probable that it will be found again in the Territory." We have in the University of Alaska Museum, however, a specimen (UA 200) of an adult female in summer plumage collected by Calvin J. Lensink on the Iditarod Flats of the Iditarod River (lat. 63° 10′ N, long. 158° 30′ W) on June 24, 1951. Another specimen (UA 1067) was collected by Ludwig J. Rowinski on August 1, 1957, at Small Lake (lat. 67° 22′ N, long. 143° 48′ W), about 70 miles northeast of Fort Yukon. This latter bird was a lone, fall-plumaged male feeding on a windrow of dead vegetation along the shallow shore of the lake; it weighed 285.6 grams.

Chordeiles minor. Common Nighthawk. On the evening of July 12, 1958, near College, a nighthawk circled about directly overhead for about five minutes, calling clearly; it was observed by Frederick C. Dean, Ludwig J. Rowinski, and Gerald A. Vogelsang. The only other Alaskan records north of the parallel 60° are a dead bird found by an Eskimo chief about 10 miles north of Allakaket (lat. 68° N, long. 153° W) in the fall of 1923 (Murie, Auk, 42, 1925:270–271), and an adult male collected by Brower at Barrow on July 6, 1941 (Bishop, Zool. Ser., Field Mus. Nat. Hist., 29, 1944: 181–190). Cantwell (Osprey, 3, 1899:25), however, reported nighthawks breeding at the headwaters of the Sixty-mile River in Yukon Territory, just across the Alaskan-Yukon border; and on August 9, 1956, I saw and heard a number of these birds along the Klondike Highway about 80 miles east of Dawson, Yukon Territory.

Sturnus vulgaris. Starling. The first sight record of a Starling in the interior of Alaska was made on May 4, 1960. While with a class at Creamer's Dairy Farm, I watched a Starling for a short period as it flew about the barns and pasture. It seemed extremely wary and restless, and it would land only momentarily before taking flight again. It soon disappeared beyond the fields and has not been seen since.

Empidonax hammondii. Hammond Flycatcher. The fact that there are no published records of this flycatcher in interior Alaska is misleading. The Hammond Flycatcher is probably the commonest resident flycatcher in the Fairbanks area during the summer, and it is the earliest to arrive in the spring. The species prefers a habitat of relatively open woods formed by the tall, deciduous trees of poplar (*Populus tremuloides* or *P. balsamifera*) or white birch (*Betula papyrifera*); conifers apparently are not an environmental requirement. I have often stood in such a woods in late May and heard two or three males calling concurrently.

Phylloscopus borealis. Arctic Warbler. I heard Arctic Warblers singing and watched several feeding on June 20, 1958, in a patch of dwarf birch (*Betula glandulosa*) along a draw beside the Denali Highway, about seven miles west of the Maclaren River. In view of the date and the behavior of these birds, I judged them to be residents in the area. This locality represents an extension of over a hundred miles eastward from the previously known range of this species.

Spizella passerina. Chipping Sparrow. There are only a few published records of Chipping Sparrows in Alaska: Brower collected one at Point Barrow on September 18, 1929 (Bailey, Birds of Arctic Alaska, 1948), and Francis H. Fay observed one at Gambell, St. Lawrence Island, on May 23, 1956 (Fay and Cade, Univ. Calif. Publ. Zool., 63, 1959:73–150). There apparently has been, however, a range extension along the Tanana River Valley into interior Alaska by birds from Yukon Territory. On the morning of May 27, 1958, I watched a male Chipping Sparrow as it sang almost continuously from a stand of tall willows at College. The specimen (UA 1068) weighed 11.5 grams, and the testes measured 8 × 5 and 6 × 5 mm. In 1959 four nesting records were obtained along the Tanana Valley. At Tetlin Lake Donald E. McKnight found a nest with 4 eggs on July 3, 10 inches up in a rose bush (*Rosa acicularis*); and in the same area James King found one with 3 eggs on July 6 in a 3-foot spruce. Svein Haftorn found two nests containing young in white spruce at Big Delta on July 10, 1959 (Haftorn, Det. Kgl. Norske Vidensk. Selsk. Forh., 32, 1959:107–111).—BRINA KESSEL, *University of Alaska, College, Alaska, April 18, 1960.*

Notes on Vaux and Chimney Swifts.—There have recently been two instances of Vaux Swifts (*Chaetura vauxi*) seeking night roosting shelter in chimneys near San Diego, California. On May 4, 1960, Mrs. Edith Heller brought to the Natural History Museum in San Diego a specimen of a Vaux Swift for verification of identity. She reported that shortly after sundown, on the evening of May 3, a flock of about 25 of these swifts came down the fireplace chimney into the living room of a residence in the Point Loma district of San Diego. The day had been misty with intermittent showers, and there was a prediction of sharper showers during the night so that conditions were such that the birds were seeking shelter for the night. After some commotion one bird was captured; this is the swift she brought in and it is now a specimen in the collection of the museum. Mrs. Heller also stated that a like occurrence had taken place in May five years ago at the same residence when a much larger flock had descended the chimney for a night's shelter.

On preparing the specimen I found a small amount of material in the stomach. As little seems to be recorded of the food of this species, it was saved for study by Dr. F. X. Williams and Mr. C. F. Harbison, entomologists on the museum staff. The contents had been heavily digested and appeared to be a black pasty mass, highly mutilated, with no pieces large enough to see with the naked eye. However, with the aid of a microscope, they were able to find insect fragments representing three orders: Lepidoptera, Diptera and Hymenoptera. These flying insects had apparently been caught by the bird before it sought shelter for the night.

Mrs. Heller subsequently returned with a further report. On the evening of April 23, 1960, a flock of swifts estimated to have been 500 birds flew down the fireplace chimney at the residence of Mrs. Robert Mosher in La Jolla. They descended the chimney in such numbers that most of the soot that had accumulated on the chimney walls was brought with them into the room. The police were called to help remove the birds and next day the interior decorators were called to repaint the walls and revamp the furniture! The writer found that April 23 had been overcast and showery as was the 24th, so without question the migrating swifts were seeking shelter from inclement conditions.

A further record of importance is the capture of a Chimney Swift (*Chaetura pelagica*) within the boundary of California. The bird was a male and is now in the collection of the San Diego Society of Natural History (no. 13055); it was collected in the willow-cottonwood association, 1 mile north of Potholes, Imperial County, California, on the Colorado River, May 6, 1930, by Samuel G. Harter. This record adds another species to the list of California birds.—LAURENCE M. HUEY, *San Diego Society of Natural History, San Diego, California, May 20, 1960.*

Notes on the Nesting of the Roadrunner.—In Bent's Life Histories (U. S. Nat. Mus. Bull. 176, 1940) the account of the nesting of the Roadrunner (*Geococcyx californianus*) states (p. 41) that "it is supposed that only the female incubates"; it is also suggested that it had not been proved that second sets of eggs are laid by females that had already succeeded in bringing out one brood.

Perhaps more definite data have since been published, but it may be of interest in any event to record the following observations made this year at the writer's home in Covina Highlands, about 25 miles east of Los Angeles, California.

During the first half of March a pair of Roadrunners was noticed carrying small sticks and stems into the middle of a large, compact clump of cactus of the subgenus *Platyopuntia*. On March 19 the female was seen sitting on the nest and presumably incubating, although a clear view of the bottom of the nest could not be obtained because of its depth and inaccessibility. Most of the incubation seemed to be done by the female, but the birds were observed to relieve each other on the nest, and the eggs were seldom left uncovered. Occasionally, when the male was not near, the female would leave the eggs briefly in order to forage in the immediate vicinity of the nest.

On April 5, 16 days from the apparent beginning of incubation, an egg and a newly hatched young bird could be seen, and on April 7 three young were visible. While the young birds were small, the parents would brood them for a while after bringing food. In reaching the nest they always climbed over the cactus, but they flew down when leaving. As the nestlings became well grown, the male parent was perhaps the more active in bringing provisions, which consisted mainly of fence lizards (*Sceloporus occidentalis*) and alligator lizards (*Gerrhonotus*). Large grasshoppers were also brought, as well as unidentified smaller invertebrates. No other vertebrate prey was noted. During the nesting activities the male often flew to the top of the house roof to coo, sometimes while holding a lizard in his bill.

The Roadrunners made no attempt to avoid betraying the location of their nest and showed surprisingly little concern over the presence of an observer. The female, in particular, would approach within seven or eight feet while foraging, and she was not alarmed by movements.

On April 25 it was found that two of the young had left the nest, the third remaining about two days longer. On April 29 the Roadrunners were again adding material to the nest, which had been kept in a perfectly clean condition, and on May 2 an egg appeared. The additional material had raised the bottom of the nest so that its contents were more clearly visible. A second egg was laid on May 4, incubation beginning on May 6, although it was somewhat intermittent for the first day or two. A third egg which may have been previously concealed from view was discovered later.

On May 9 and 10 the three young of the first brood, now hardly distinguishable from the adults, were seen following the male parent and begging for food, with undetermined success. Through most of the incubation period, both birds continued to bring small bunches of soft, dry grass when taking their turns on the nest. As the hatching time approached, the female seemed to be occupying the nest continuously during the day, except for a respite in late afternoon, when she would run up the driveway to meet her mate, who had cooed from a distance and was approaching with a lizard in his bill. After transferring the lizard, the male would proceed to the nest while the female went farther afield. The rooftop cooing was not resumed during the second nesting.

Two young were hatched on May 24, or possibly the preceding evening, the third within two or three days. The feeding of this brood was much the same as in the first case, except that fewer large alligator lizards were noted. The number of these lizards previously brought was entirely unexpected, as they are seen only occasionally. For this reason it is impossible to estimate to what extent their numbers may have been depleted. As for the fence lizards, they did not become noticeably scarce at any time, even immediately around the clump of cactus which contained the nest. Intervals between visits to the young varied greatly, sometimes lengthening to an hour or more in the late afternoon. Prey was captured by cat-like stalking, climaxed by a swift lunge, after which the victim was pounded vigorously against the ground.

The first young bird left the nest on June 13, and on the following morning the other two were found outside but near the nest. After the next visit of one of the parents, the second bird had disappeared, whereas the third and presumably youngest returned to the nest to remain another day. Thus the records of the two broods indicate that Roadrunners remain in the nest for about 20 days after hatching. The female parent began molting her tail feathers just before the second brood left.

Despite the more or less juicy nature of their food, Roadrunners often drink copiously. Smaller birds, except when engaged in raising young, paid little attention to them, but when the Roadrunners were harried by nesting jays, they reacted belligerently.—Robert S. Woods, *Covina, California, June 17, 1960.*

Further Evidence of Hybridization between Zonotrichia atricapilla and Zonotrichia leucophrys.—On March 11, 1960, in the foothills east of San Jose, California, we captured with mist nets 21 Golden-crowned Sparrows (*Zonotrichia atricapilla*). These were from a mixed winter flock which also included White-crowned Sparrows of two races, *Zonotrichia leucophrys gambelii* and *Z. l. pugetensis*. The birds were transported to San Jose State College to be used for investigations on the physiology of migration. At time of capture they were just beginning the pre-nuptial molt. By the last week of April the molt was completed except in birds that had been castrated on March 21. In early May we observed that one of the castrates (56–164252) completing its pre-nuptial molt had a white superciliary stripe. Closer examination made it apparent that this bird possessed characteristics of both the Golden-crowned and White-crowned sparrows. Our data show that at the time of capture we considered it a "sub-adult" Golden-crowned Sparrow with crown type 2 (max.) of Cogswell (News from the Bird Banders, 33, 1958:24–28). It progressed to 2–A by April 16 and to 5A-C by April 30. On May 28 this bird was found dead in its cage and was made into a study skin (SJSC Vertebrate Museum, no. 3031). There was no apparent regeneration of testicular tissue.

Miller (Condor, 42, 1940:45–48) described a hybrid between *Z. atricapilla* (then *coronata*) and *Z. leucophrys* taken in the spring of 1939 at Berkeley, California. Our bird appears to be the second such hybrid represented by a skin. Through the good offices of Dr. Miller, we were able to compare the specimens side by side in the preparation of this report.

The crown patterns of the two birds are strikingly similar. As in Miller's bird, comparison to *Z. l. gambelii* seems indicated because of the similarity of the head stripes to those of that subspecies. The distribution of the gold in the center of the crown and the gray area extending to the nape of both birds are characteristic of *atricapilla*. A yellow spot above the eye of our specimen is the same as that described by Miller for the bird of 1939. Again the absence of black (of *atricapilla*) apparently permits this yellow to be expressed in this otherwise white area (of *gambelii*). The yellow of our specimen is very pale, but this pale coloration is manifest in 49 of 51 Golden-crowns held in captivity through the pre-nuptial molt. We feel this is probably an artifact attributable to a diet which may have been low in carotinoids.

Whereas the dorsal and ventral surfaces of our bird are typical of *atricapilla*, the dorsal surface of Miller's bird resembles *atricapilla* while the ventral surface is lighter and more closely resembles *gambelii*. The bill color of our bird nearly matches *atricapilla*, but it may be slightly lighter. The bill of Miller's bird approached the pink of *gambelii*.

Table 1

Measurements of Hybrid *Zonotrichia atricapilla* x *Zonotrichia leucophrys* in Millimeters

	1939 hybrid	1960 hybrid
Wing length (chord)	75.5	80.0[1]
Tail length from emergence of central rectrices	72.5	76.1[2]
Bill length from nostril	8.5	8.3
Bill depth at nostril	7.0	7.3
Tarsus	23.6	24.8
Middle toe without claw from between second and third toes	14.1	14.5
Hind toe without claw	9.6	10.5
Claw of hind toe	6.9	8.1

[1] Taken April 30 before appreciable cage-wear to wing tips.
[2] From skin, tail slightly worn.

The more easily observed differences between the hybrids are in size (table 1). Our bird weighed 45.5 gm. on April 23, dropped to 40.0 gm. by April 30 and retained that weight for nearly a month thereafter. The weight on April 23 was 6.1 gm. above the mean for 33 castrates on the same day. After that date, however, and until its death, the hybrid's weekly weight did not deviate more than 0.8 gm. from the mean weight of the castrates. Twenty-nine to 31 unoperated males maintained a mean body weight approximately 2.0 gm. heavier than the castrates during this same period, indicating that castration did not cause this bird to be abnormally heavy. Miller's bird weighed 33.6 gm. on April 24, some 11.9 gm. less than our bird on April 23. The body measurements support the weight

differential. Our hybrid is consistently larger and its measurements appear to be more typical of *atricapilla*.

Despite the size differential, these two specimens are quite similar, lending support to Miller's speculation that his hybrid may be of the first filial generation. The fact that they were captured 21 years apart in time but only about 30 air miles apart in distance makes one wonder if they may have come from the same breeding population.—MARTIN L. MORTON and L. RICHARD MEWALDT, *Department of Biological Sciences, San Jose State College, San Jose, California, July 20, 1960.*

Changes in Food Habits of Short-eared Owls Feeding in a Salt Marsh.—Predation by Short-eared Owls (*Asio flammeus*) on the inhabitants of a salt marsh was reported for a four-year period (1952–1955) by Johnston (Wilson Bull., 68, 1956:91–102), who randomly collected and examined owl pellets from San Pablo salt marsh, near Richmond, Contra Costa County, California. The present author collected and examined owl pellets on this same marsh during 1959 with a view to demonstrating suspected changes in the predator-prey relationships there. A total of 170 food items was recorded and percentages of the prey species computed for comparison with the figures available for this marsh. A description of the habitat involved is given in Johnston's paper (*op. cit.*: 91). As in Johnston's report, all owls involved here are migrants or winter visitants. One owl, however, remained through June, 1959, although departure for the breeding grounds usually occurs in early May. The total number of owls feeding on the marsh was probably six to eight, a figure comparable to the estimate made by Johnston (*op. cit.*: 93).

The data in table 1 were assembled in the manner followed by Johnston with the exception that counts of humeri (left or right, whichever was higher) instead of skulls only were made for mammals. This resulted in a slightly higher number than if skulls alone had been counted. In the column of the table headed "change from 1952–1955," a percentage is considered different if it is outside the range of Johnston's figures (*op. cit.*: 95). A few species listed by him were not recorded in 1959, but these form only a very small part of the diet of the Short-eared Owl on San Pablo salt marsh.

Examination of the present table and that of Johnston (*loc. cit.*) shows that most prey items have been taken at a constant rate over the five years for which data are available. However, notable fluctuations did occur in the numbers of the Norway rat (*Rattus norvegicus*) and the Water Pipit (*Anthus spinoletta*).

Johnston (*op. cit.*: 96) noted that there was apparently some relationship between the numbers of the California vole (*Microtus californicus*) and *Rattus* in the pellet samples. From 1952 through 1955 the numbers bore an inverse relationship as the rats increased in number in the sample. However, my data for 1959 show the situation is more comparable to 1952 when the rat population was apparently low and *Microtus* apparently high. The probable reason for this was that during the period from 1952 to 1955 rats inhabiting the nearby dump had direct access to the marsh. The Richmond city dump then in operation was located on the southeast side of the marsh and dumping was directly onto the marsh. A suggestion by Davis (Quart. Rev. Biol., 28, 1953:397) indicates that it is probable that competition resulting from high rat populations forces subordinate individuals to move out in search of more favorable conditions. Emigrating individuals forced out by an increase in the dump population here could easily move out into the marsh. In January, 1956, this dump was closed and a new dump on the north side of the marsh was placed in full operation. The new dump is connected to the marsh study area only by a secondary road, and rats do not have the free access to the marsh that they had previously. In addition, burning of refuse, practiced in the old dump, may have driven some rats into the marsh. Burning is prohibited in the present dump. The policy now in use of burying refuse continually changes the dumping area, a factor which presumably helps check the population of rats at the dump.

Johnston (*loc. cit.*) pointed out that the population of *Rattus* at the dump supplied animals to the marsh but that the rats also lived successfully there. However, it is probable that the rats actually do not live permanently in this marsh in large numbers without regular emigration into it. When the first dump was closed, rats no longer invaded the marsh and so the population dwindled. I have seen only a few rats and trapped just one in 20 months of mammal studies on San Pablo salt marsh. Furthermore, during the winter high tides which flood the marsh and force mammals into the open,

no rats were seen. Therefore, it appears that rats have been effectively eliminated from the marsh and owls once more rely on *Microtus* as their dominant food item.

The change in the number of Water Pipits in the pellet sample may be attributable to the change in the rat population. Large numbers of pipits roosted on the marsh during the winter periods of 1959. Probably those birds were not present in such large numbers in the period from 1952 to 1955 because of disturbance and predation by rats. Now, with the rat population practically eliminated, these birds abound on the marsh. When roosting, pipits are considerably more exposed than any of the resident bird species and so are more easily procured by Short-eared Owls.

Table 1

Food Items in Pellets of the Short-eared Owl, 1959

Species	Frequency	Per cent of total	Change from 1952–1955
Microtus californicus	86	50.6	None
Reithrodontomys spp.	17	10.0	None
Mus musculus	7	4.1	None
Rattus norvegicus	4	2.4	4.8 per cent below lowest yearly percentage; 15.6 per cent below four-year average
Sorex vagrans	4	2.4	None
Mammals: total	118	69.5	5.1 per cent below lowest yearly percentage; 10.3 per cent below four-year average
Erolia-Ereunetes	14	8.2	None
Anthus spinoletta	9	5.3	4.8 per cent above highest yearly percentage; 5.1 per cent above four-year average (only one recorded previously)
Unidentified birds	5	2.9	None
Sturnella neglecta	4	2.4	None
Passerculus sandwichensis	4	2.4	None
Limnodromus griseus	3	1.8	Not significant
Melospiza melodia	2	1.2	None
Birds: total	41	24.2	3.6 per cent above highest yearly percentage; 8.7 per cent above four-year average
Stenopelmatus (sand-cricket)	9	5.3	None
Unidentified insects	2	1.2	Not significant
TOTAL	170	100	

A further consequence of the removal of the dump area is the change in the foraging behavior of the owls. Johnston (*op. cit.*: 93) stressed the "almost complete absence of daytime feeding" on this marsh. He attributed this to the mobbing of owls by gulls gathered about the dump. The old dump was located at the upper edge of the marsh, and gulls had to fly across the marsh to it. The new dump is located directly on the bay, and gulls no longer need to fly over the marsh to reach it. As a result the owls can now forage during the daytime also as is common on their breeding grounds (Errington, Condor, 34, 1932:178). The owls seldom, if ever, forage in the dump, presumably because of the constant presence of gulls.

Therefore, with the virtual elimination of gulls and rats from the marsh area, the Short-eared Owls have changed their foraging habits and their dominant prey item. Unavailability of rats forced them to consume more *Microtus* again, but apparently this alone was not sufficient in 1959. In spite of a distinct preference for small mammals over small birds as food items (Errington, *loc. cit.*), the owls also utilized small birds, particularly Water Pipits, the most readily available, to augment their food supply.—GEORGE F. FISLER, *Museum of Vertebrate Zoology, Berkeley, California, August 17, 1960.*

NOTES AND NEWS

The present number of the Condor concludes volume 62 and brings the pagination for the year to 500, the first time in the history of the journal that we have been able to present so large an amount of scientific material. Be it known, however, that the editors do not strive for quantity production but above all insist on material of good quality for presentation. That we have been able to offer 500 pages this year is a mark, then, of the sound productivity of scientists associated with the Cooper Society and interested in publishing in its journal.

In the course of the year the editors have had the help of many people without which it would have been impossible to produce the journal of the present scope and value. Besides the work of the editorial staff and the advisory committee recorded on our title page for the volume, we mention the special aid given by Gene M. Christman, who in fact has served as illustrations editor, and of Richard C. Banks and George F. Fisler who have assisted in proof reading. We have benefited from editorial appraisals from persons outside our advisory committee as follows: Howard A. Bern, Robert I. Bowman, Charles H. Danforth, Richard C. Banks, Keith L. Dixon, Herbert Friedmann, Harvey I. Fisher, Joe T. Marshall, Jr., and L. Richard Mewaldt. Beyond the call of regular duty Jane R. Durham has contributed the annual index. To all the persons listed as well as those serving in official positions in the editorial organization, cordial thanks are extended.—A.H.M.

The color plate in the current issue was made possible by the generous gift of Mr. Hart Isaacs, and the original which it represents was contributed by the artist, Don R. Eckelberry. To both gentlemen the Cooper Ornithological Society is much indebted.

The annual meeting of the Cooper Society in 1961 will be held in Tucson, Arizona, on April 6, 7, 8, and 9, under the sponsorship of the University of Arizona, The Arizona Academy of Sciences, and the Arizona-Sonora Desert Museum. Joe T. Marshall, Jr., has been designated as chairman of the committee on arrangements. Thomas R. Howell will be in charge of the scientific program.

The Division of Biological and Medical Sciences of the National Science Foundation announces that the next closing date for receipt of basic research proposals in the Life Sciences is January 15, 1961. Proposals received prior to that date will be reviewed at the spring meetings of the Foundation's advisory panels and disposition will be made approximately four months following the closing date. Proposals received after the January 15, 1961, closing date will be reviewed following the summer closing date of May 15, 1961.

The next closing date for submission of proposals for specialized biological facilities is March 1, 1961. The NSF has two programs for support of facilities, one for general graduate level university laboratories and the other for specialized biological facilities. The latter are defined as discrete research installations which are unique, one-of-a-kind, or at least less than ordinary in that they are not a usual part of a university department and may represent either new ventures or the more traditional establishments.

Inquiries should be addressed to the National Science Foundation, Washington 25, D.C.

Awards for ornithological research are made in April of each year by the Frank M. Chapman Memorial Fund Committee of the American Museum of Natural History, New York. Applications should be received by March 1.

The Thirteenth International Ornithological Congress will be held at Cornell University, Ithaca, New York, U.S.A., from June 17 to 21, 1962. The President is Professor Ernst Mayr.

The International Ornithological Congresses are scientific meetings which have been held at intervals since 1884. Since 1926 a four-year cycle has been maintained except for a twelve-year interruption caused by World War II. The previous Congresses have been held in continental Europe and England.

Persons wishing to receive further announcements and membership application forms for the Thirteenth International Ornithological Congress should send their names and permanent mailing address to the Secretary-General, Professor C. G. Sibley, Fernow Hall, Cornell University, Ithaca, New York, U.S.A., before February 1, 1961.

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